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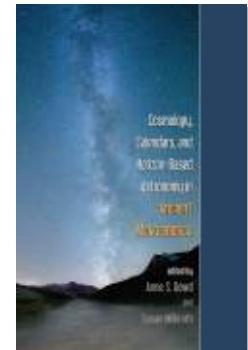


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Cosmology, Calendars, and Horizon-Based Astronomy in Ancient Mesoamerica

Anne S. Dowd, Susan Milbrath

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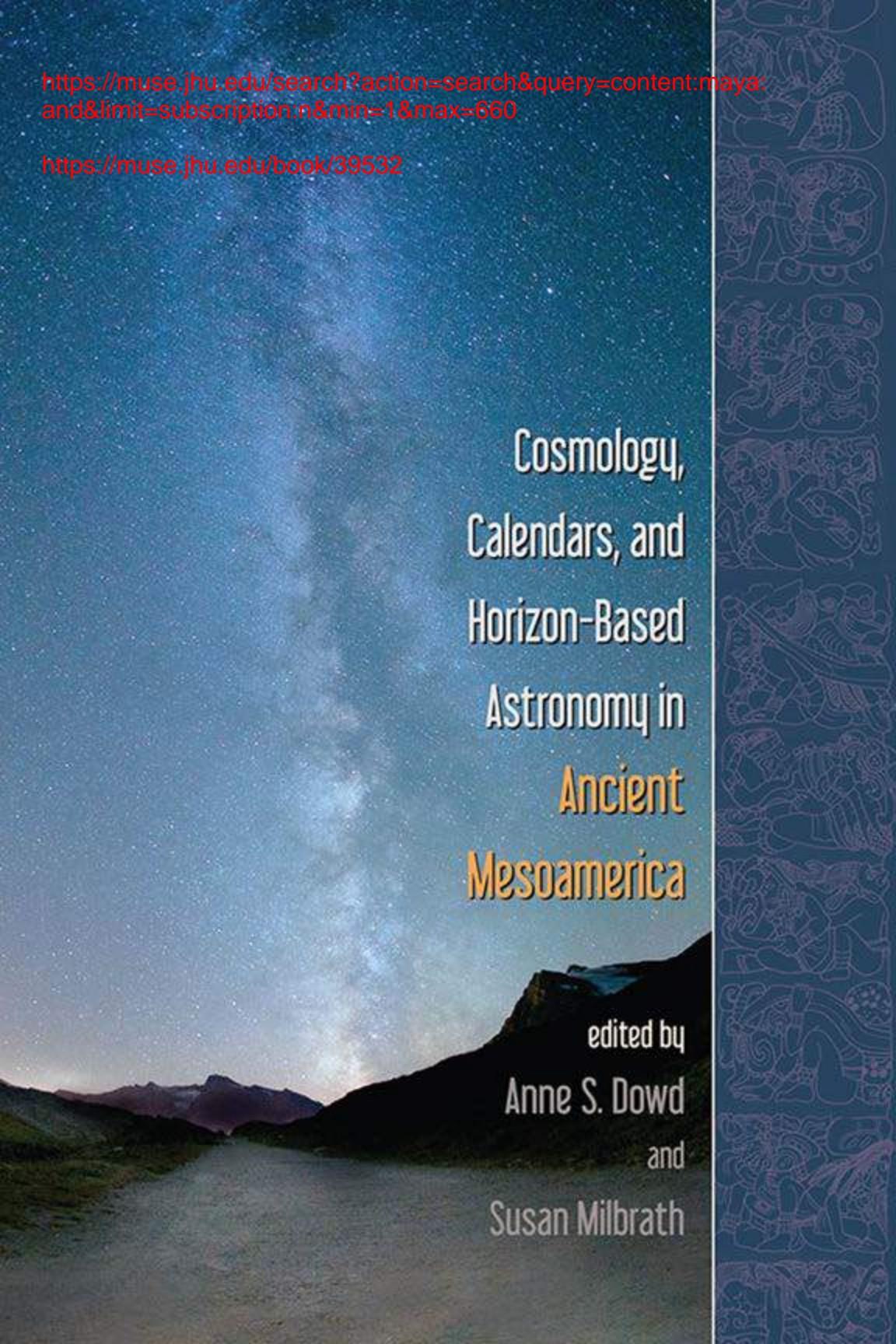
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Cosmology, Calendars, and Horizon-Based Astronomy in Ancient Mesoamerica

edited by
Anne S. Dowd
and
Susan Milbrath

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Cosmology,
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Edited by
Anne S. Dowd and Susan Milbrath

FOREWORD BY E. C. KRUPP

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FIGURE 0.0. *Arquitecto Horst G. Hartung Franz, shown with two of his students, Dr. Sharon Gibbs, then a Sloan Postdoctoral student at Colgate, and Colgate University student Barb Toner (photograph by Lorraine Aveni).*

The authors of *Cosmology, Calendars, and Horizon-Based Astronomy in Ancient Mesoamerica* dedicate this book to Horst G. Hartung Franz, Ph.D. (1919–1990).

Dr. Horst G. Hartung Franz was an architect who for much of his career was affiliated with the Centro Universitario de Arte, Arquitectura y Diseño (CUAAD) in Guadalajara, Mexico. Dr. Hartung earned his doctorate from the University of Stuttgart in 1965. He taught with Anthony F. Aveni during a number of Colgate University January Field Study Programs or “Jan Plans.” Besides coming along to teach on field expeditions and engaging students in a warm and friendly way, Horst also was Tony Aveni’s collaborator and coauthor on a number of influential publications, some of which are listed below. Their book *Maya City Planning and the Calendar* is an especially important contribution to Mesoamerican studies.

SAMPLE JOINT PUBLICATIONS

- Aveni, Anthony F., and Horst Hartung. 1986. *Maya City Planning and the Calendar*. Transactions of the American Philosophical Society 76, part 7, 1–87. Philadelphia: American Philosophical Society.
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Foreword

About two katuns ago, astronomer Anthony F. Aveni collaborated with architect Horst Hartung and organized in 1973, in Mexico City, the first formal, scientific meeting dedicated to ancient and prehistoric astronomy. Most of the presentations spotlighted the American Southwest and Mesoamerica, and Aveni (1975) subsequently edited a selection of the papers into *Archaeoastronomy in Pre-Columbian America*. At that time, archaeoastronomy was dominated by the study of astronomical alignments in monumental architecture, but the Mexico City session added iconography, hieroglyphic texts, ethnography, cosmology, calendars, and artifacts to the discussion. Before 1973, archaeoastronomical initiatives primarily targeted what the ancients knew about the sky. At that meeting, however, archaeoastronomy began to look more deliberately and energetically at the sky's impact on culture. The participants especially took advantage of the numerous known ways in which Mesoamerica expressed its astronomical interests.

Although no one could prophesy in 1973 that two katuns of Mesoamerican archaeoastronomy would evolve into the robust, disciplined, and remarkably detailed enterprise exemplified by this new collection of studies, Aveni drove the whole field in this direction. In the introduction to *Archaeoastronomy in Pre-Columbian America*, Aveni already had a sense of how this work had fallen short, how it should proceed, and what it would take to make it effective

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and Anthony Aveni*

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and meaningful. “Properly placed as a cooperative interdisciplinary venture” archaeoastronomy, Aveni (1975, xiv) explained, “might have revealed more about ancient man’s awareness of his large-scale environment than is already known.” Most studies up to that time were analytically isolated and culturally anecdotal. Aveni made clear the need for interdisciplinary collaboration. His priority was astronomy’s “relevance to our understanding of the development of civilization and culture” (1975, xiv). A promotional description on the book’s dust jacket amplified his point: unless researchers “possess some knowledge of the cultures with which they are dealing,” their efforts will miss the mark.

From the beginning, Aveni has insisted these astronomical inquiries be rooted in an anthropological perspective that requires the participant to embrace the priorities, protocols, and properties of every discipline that may have a bearing on our ancestors’ interactions with the sky. Astronomy tells us what the universe is and how it works, but astronomy is a human enterprise. Astronomy is everywhere in human affairs, and its presence and influence in so many aspects of life requires explanation. We need to know what we do with astronomical knowledge and why it matters to us, and that takes a full and informed investment that goes beyond the range of any specialty.

Anthony Aveni pioneered the modern era of the study of the cultural dimensions of astronomy, and he put the “inter-” into interdisciplinary as far as the study of ancient, prehistoric, and traditional astronomy is concerned. His effort and success are not just defined by his work but by his influence on others. He has collaborated with different specialists on behalf of a more persuasive distillation of meaning from the evidence of alignments, symbols, and texts, but his interdisciplinary reach goes beyond his work with other experts. He has also persuaded others to take the same approach and has encouraged them to find and work with those who possess the kinds of expertise that will put the astronomical activities of antiquity in cultural context and make clear the cultural function of ancient astronomical endeavors. He has made those principles visible in the conduct of his work, and he has activated them in others through the development of a two-katun tradition of interdisciplinary meetings and publications that continues with this new volume.

Aveni has guided specialists and scholars toward a more fully configured appreciation of ancient astronomy, but he has also altered public perception of astronomy in ancient Mesoamerica. When he began his fieldwork in Mexico and Central America, the Maya were popularly understood to have kept a remarkable calendar and to have observed the sky, but the general

public had Erich von Däniken to thank for much of the rest of the public profile of the Maya. In *Chariots of the Gods? Unsolved Mysteries of the Past*, von Däniken (1969) linked the Maya to ancient astronauts through the portrait of a Palenque king on the lid of a stone sarcophagus, and he absurdly imposed a modern observatory dome on a tower at Chichén Itzá. For the last forty years, Aveni has provided an antidote to such afflictions. In at least ten books for the general reader, in numerous magazine articles, in television and radio appearances, and in many public lectures, Aveni has provided accurate accounts of ancient astronomy and its cultural implications, and his influence has been multiplied by those who have read his work and further popularized it.

In the run-up to the December 21, 2012, end of the Maya calendar, or “End Times Follies,” and the completion of baktun 13, it was fitting that Aveni (Saturno et al. 2012), in collaboration with two archaeologists and an epigrapher, reported and analyzed newly discovered Maya hieroglyphic astronomical tables, the first known to have been prepared in the Classic period (A.D. 200–900). Aveni’s remarks about the astronomical calculations, which reference dates far past 2012, were widely reported in the news, and they contradicted the extravagant and pseudoscientific claims about the Maya calendar that had captured public interest.

This new book, *Cosmology, Calendars, and Horizon-Based Astronomy in Ancient Mesoamerica*, honors more than two katuns of Aveni achievement, and in fact, it’s unlikely that these papers would exist today, at least not in their present form and without an accurate appreciation of their meaning, if not for Aveni’s cultivation of the ideas they contain, his development of a framework for their significance, and his encouragement of the effort behind them. The cultural context of building alignments, ceremonial center orientations, codices, calendars, iconography, and sky lore and the functions of these astronomical efforts are examined here with far more depth and direction than was possible two decades ago. It is now easy to see that astronomy in Mesoamerica, like astronomy elsewhere in antiquity, was primarily modulated by latitude, climate, and social complexity. The kind of astronomy people do and the use they make of it are functions of culture, and that goes for us, too.

The contrast between the studies in this volume and the papers published in 1975 in *Archaeoastronomy in Pre-Columbian America* is striking, but the continuity is stunning. Even the Las Bocas pectoral has put in an appearance again. This book is a milestone, and its sophistication indicates just how far down the *sacbe* we’ve come.

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Preface

Both Susan and I have enjoyed the process of bringing together such a talented group of scholars in Anthony Aveni's honor, and we hope that you, the reader, will find the resulting volume stimulating reading and useful for inspiring new research paths in cultural astronomy. We first met thanks to Tony's energetic and enthusiastic mentorship and have known many of the colleagues represented in this volume for most of our careers. Besides giving us the chance to reflect upon our wonderful relationship with Tony and his wife Lorraine, this project makes us especially grateful for having had the intellectual support and friendship of the other authors in this book.

All of us have been privileged to be part of a sea change in the world of Mesoamerican studies. Our generation of scholars has witnessed the shift from studying a number of Mesoamerican groups as prehistoric cultures, to cultures with not only history but, in the case of the Maya, a historical record that can be read and pondered, with agents of change who have names, birthdays, accession dates, and burial rites. In this sense, then, not only has the region been studied using a series of theoretical and methodological perspectives such as culture history, processual archaeology, and finally post-processual anthropology, but it has borne out the old adage in archaeology or in science generally that you find what you are looking for—by the time that post-processual scholars were calling for a more individual look at culture change, Maya



FIGURE 0.1. *Symposium participants from left to right: Ronald Fauseit, Ivan Šprajc, Gabrielle Vail, Anne Dowd, Flora Clancy, Harvey Bricker, Anthony Aveni, Susan Milbrath, Lorraine Aveni, Victoria Bricker, John Justeson, and Clemency Coggins* (photograph by Donald A. Slater).

hieroglyphic studies had progressed to the point that many written records could be read and understood. This means that for those Mesoamerican groups with a preserved historical record, the potential for understanding cultures in a particularistic sense can be realized in a more convincing way than we ever expected.

Written records often treat the most powerful within these societies, but decades of settlement pattern studies have also shown us how the farmers lived. Slowly, inexorably, information has been gathered from a solid sample of house mounds, sites, *sacbes*, monumental architecture, agricultural fields, and reservoirs to provide a wealth of information about the people who lived and worked to create the extraordinary civilizations that we have been so patiently studying. Because we now have an enormous database on community organization combined with other categories of information that include murals recording aspects of ritual and daily life, written records on the calendar, warfare and alliances, seasonal rites, political events, and individuals' accomplishments, the New World offers tremendous potential for understanding how civilizations rose and fell.

We are looking forward to the next few decades in Mesoamerican studies during which we hope to research the variable forms of state development,



FIGURE 0.2. SAA president Frederick Limp presenting Anthony F. Aveni with the Fryxell Medal and Plaque (photograph by Anne S. Dowd, © 2013, all rights reserved).

ranging from primary to secondary, and to better understand how and where hunter-gatherer populations settled down and began growing domesticated plants and animals. The information we need to pursue these “big” questions about cultural universals and changes in subsistence and social organization is now available for study. Various authors in this volume show us how specific details of calendar units, artifact function, and architectural design provide a window on social institutions that emerged to create complex city-states in the region. The Mesoamerican groups studied in this volume include the

Maya (Aveni, the Brickers, Carlson, Clancy, Coggins, Dowd, Freidel and Rich, Justeson, Šprajc), the Zapotec (Faulseit, Justeson), the Olmec (Coggins, Rice), the Teotihuacanos (Freidel and Rich), and the Postclassic Central Mexicans (Milbrath).

The work presented here began as a symposium at the Society for American Archaeology (SAA) in Memphis, Tennessee, on April 22, 2012, titled “Cosmology, Calendars, and Horizon-Based Astronomy in Ancient Mesoamerica: Papers in Honor of Anthony F. Aveni” (figure 0.1). We are thankful to the authors for their interest and enthusiasm and for making this interdisciplinary book honoring Tony a reality. It is appropriate that at the SAA meeting in Honolulu, Hawaii, 2013, Dr. Aveni received the Fryxell Award for Interdisciplinary Research in the Earth Sciences category (figure 0.2).

October 14, 2013

13.0.0.14.17—2 Kaban 15 Yax (GMT = 584,283)

A. S. DOWD, VAIL, COLORADO

S. MILBRATH, GAINESVILLE, FLORIDA

Acknowledgments

The editors would like to acknowledge Anthony F. Aveni's long mentorship, which has helped both of our careers. Anne S. Dowd received her B.A. degree at Colgate University, where Tony Aveni was her undergraduate advisor in a topical Prehistory major. Susan Milbrath benefited from Aveni's assistance beginning in 1979 when she received a Tinker Postdoctoral Fellowship at Yale University, working under the guidance of Tony and Michael D. Coe. In addition, Anne S. Dowd would like to thank Professor Emeritus Flora S. Clancy, with whom she studied art history at Colgate University and who contributed a chapter in this volume. Her untimely death in October 2014 makes us especially grateful that she was able to contribute a polished paper for this volume. Our thanks also go out to Ms. Diane Janney, administrative assistant at the Colgate University Department of Physics and Astronomy, who assisted in organizing the symposium "Cosmology, Calendars, and Horizon-Based Astronomy in Ancient Mesoamerica: Papers in Honor of Anthony F. Aveni" on which this edited volume was based (held at the Society for American Archaeology, Memphis, Tennessee, April 22, 2012). Both the editors are indebted to Mr. Darrin Pratt, the director of the University Press of Colorado in Boulder, as well as Jessica d'Arbonne, the acquisitions editor, Laura Furney, the managing editor, Daniel Pratt, the production manager, and Alison Tartt, the copy editor assigned to our book. This volume was made possible by the contributing authors' outstanding cooperation and professionalism.

Cosmology,
Calendars, and
Horizon-Based
Astronomy in
Ancient
Mesoamerica

An Interdisciplinary Approach to Cosmology, Calendars, and Horizon-Based Astronomy

SUSAN MILBRATH AND
ANNE S. DOWD

This volume highlights the latest research on the role of astronomy in ancient Mesoamerica, an area spanning Mexico south to Honduras that is of special interest in the field of archaeoastronomy. Our field has come to be known more broadly as cultural astronomy because archaeology, ethnohistory, and ethnography are all important aspects of analysis. Anthony F. Aveni's work has played a seminal role in this interdisciplinary field, and chapters published here cover many themes in his broad-ranging research. Chapters focusing on Mesoamerican horizon-based astronomy in the opening section of this book precede those that investigate the cosmological principles inherent in Mesoamerican religious imagery and rituals related to astronomy. The volume concludes with chapters that analyze Mesoamerican calendar records related to archaeoastronomy and a chapter by Aveni appraising the research compiled in this volume and other new initiatives that promise to be at the forefront of future studies.

We are happy to be riding a wave of heightened interest in Mesoamerican archaeoastronomy, enhanced no doubt by a focus in the popular press on dire predictions for the “end” of the Maya calendar on the winter solstice December 21, 2012. For years leading up to this date, people frequently asked about what the Maya said about 2012 and whether there was any validity to the astronomical events invoked. We responded by giving lectures and some even wrote books debunking the

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view popularized by new age “philosophy,” but it does remain intriguing that the Maya may have timed the rollover of the baktun cycle to coincide with the winter solstice. Here we have a chance to show how astronomy and the calendar were indeed closely linked in Maya thought. We can also raise broader issues about Mesoamerican patterns that show the role astronomy played in artistic representations, ceremonies, calendar records, architectural constructions, and urban planning. Since we are incorporating a number of different Mesoamerican civilizations, each with slightly different chronological periods, we refer the reader to table 1.1 for a comparison of time periods for the four main geographical areas covered in this volume: the Gulf Coast, Oaxaca, the Maya Lowlands, and the Central Mexican Highlands.

The long count calendar of Mesoamerica traces specific astronomical events back to at least A.D. 143, and it is now apparent that the unique Mesoamerican sacred round calendar of 260 days was used to track eclipses and the Venus cycle at this early time at sites like La Mojarra, Mexico. These findings and other cutting-edge research in this volume represent a significant contribution to current scholarship from a variety of disciplines. Interdisciplinary studies are becoming more and more popular, as it has become apparent that making new discoveries often involves going beyond the established parameters of an individual discipline.

This volume incorporates contributions by anthropologists (V. Bricker and H. Bricker, Dowd, Faulseit, Freidel, Justeson, Rice, Rich, Šprajc, and Vail), many of whom were initially trained as archaeologists or cultural anthropologists, but whose work has expanded to incorporate the tools needed to solve questions about the calendar, architectural orientations, and epigraphy. Astronomers (Aveni, Carlson, and Krupp) contributing to this volume have likewise expanded from their chosen field into the realms of archaeology, anthropology, and art historical analysis. Art historians (Clancy, Coggins, and Milbrath) included in this volume have also contributed to breaking down the barriers between the fields of study, employing data from a broad range of disciplines, including astronomy, natural history, and hieroglyphic studies. These chapters underscore the important role astronomy played in the religious and civic life of the people of Mesoamerica, and this volume will also stand as a major contribution to our understanding of Mesoamerican astronomy.

Principles of time and space, central to Mesoamerican cosmology, are embodied in codices, monumental inscriptions, and astronomically oriented architecture. Architecture designed for marking the passage of the sun along the horizon has a long history in Mesoamerica, traced back to Group E-type building complexes (resembling the typesite of Uaxactún, Guatemala) aligned

TABLE I.1. Maya Lowlands, Gulf Coast, Oaxaca, and Central Mexican Highlands Chronological Sequences

<i>Baktun/ Hafl- Baktun</i>	<i>Day</i>	<i>Month</i>	<i>Gregorian Date (GMT = 584,283)</i>	<i>Maya Lowlands</i>	<i>Gulf Coast</i>	<i>Oaxaca</i>	<i>Central Mexican Highlands</i>
o.o.o.o.o	4 Ahaw	8 Kumk'u	Aug. 11, 3113 B.C.	Archaic (3500–2000 B.C.)	Archaic (5000–2000 B.C.)	Archaic (8000–1900 B.C.)	Archaic (7000–2500 B.C.)
o.10.o.o.o	10 Ahaw	18 Sotz'	Sept. 27, 2916 B.C.	Archaic (3500–2000 B.C.)	Archaic (5000–2000 B.C.)	Archaic (8000–1900 B.C.)	Archaic (7000–2500 B.C.)
1.o.o.o.o	3 Ahaw	13 Ch'en	Nov. 13, 2719 B.C.	Archaic (3500–2000 B.C.)	Archaic (5000–2000 B.C.)	Archaic (8000–1900 B.C.)	Archaic (7000–2500 B.C.)
1.10.o.o.o	9 Ahaw	8 Kank'in	Dec. 31, 2522 B.C.	Archaic (3500–2000 B.C.)	Archaic (5000–2000 B.C.)	Archaic (8000–1900 B.C.)	Archaic (7000–2500 B.C.)
2.o.o.o.o	2 Ahaw	3 Wayeb	Feb. 16, 2324 B.C.	Archaic (3500–2000 B.C.)	Archaic (5000–2000 B.C.)	Archaic (8000–1900 B.C.)	Early Formative (2500–900 B.C.)
2.10.o.o.o	8 Ahaw	13 Sak	Apr. 4, 2127 B.C.	Archaic (3500–2000 B.C.)	Archaic (5000–2000 B.C.)	Archaic (8000–1900 B.C.)	Early Formative (2500–900 B.C.)
3.o.o.o.o	1 Ahaw	8 Yax	May 21, 1930 B.C.	Early Preclassic (2000–1000 B.C.)	Initial Formative (2000–1500 B.C.)	Early Formative (1900–850 B.C.)	Early Formative (2500–900 B.C.)
3.10.o.o.o	7 Ahaw	3 Muwan	July 8, 1733 B.C.	Early Preclassic (2000–1000 B.C.)	Initial Formative (2000–1500 B.C.)	Early Formative (1900–850 B.C.)	Early Formative (2500–900 B.C.)
4.o.o.o.o	13 Ahaw	13 Pop	Aug. 23, 1536 B.C.	Early Preclassic (2000–1000 B.C.)	Initial Formative (2000–1500 B.C.)	Early Formative (1900–850 B.C.)	Early Formative (2500–900 B.C.)
4.10.o.o.o	6 Ahaw	8 Xul	Oct. 10, 1339 B.C.	Early Preclassic (2000–1000 B.C.)	Early Formative (1500–1000 B.C.)	Early Formative (1900–850 B.C.)	Early Formative (2500–900 B.C.)
5.o.o.o.o	12 Ahaw	3 Sak	Nov. 26, 1142 B.C.	Early Preclassic (2000–1000 B.C.)	Early Formative (1500–1000 B.C.)	Early Formative (1900–850 B.C.)	Early Formative (2500–900 B.C.)

continued on next page

TABLE I.1.—*continued*

<i>Baktun/</i>	<i>Half-Baktun</i>	<i>Day</i>	<i>Month</i>	<i>Gregorian Date</i> (<i>GMT</i> = 584,283)	<i>Maya Lowlands</i>	<i>Gulf Coast</i>	<i>Oaxaca</i>	<i>Central Mexican Highlands</i>
5.10.0.0.0	5 Ahaw	18 Muwan	Jan. 13, 944 B.C.	Middle Preclassic (1000–400 B.C.)	Middle Formative (1000–400 B.C.)	Early Formative (1900–850 B.C.)	Early Formative (1900–850 B.C.)	Early Formative (2500–900 B.C.)
6.0.0.0.0	11 Ahaw	8 Wo	Feb. 28, 747 B.C.	Middle Preclassic (1000–400 B.C.)	Middle Formative (1000–400 B.C.)	Middle Formative (850–500 B.C.)	Middle Formative (850–500 B.C.)	Middle Formative (900–300 B.C.)
6.10.0.0.0	4 Ahaw	3 Yaxkin	Apr. 17, 550 B.C.	Middle Preclassic (1000–400 B.C.)	Middle Formative (1000–400 B.C.)	Late Formative (500–400 B.C.)	Late Formative (500–400 B.C.)	Middle Formative (900–300 B.C.)
7.0.0.0.0	10 Ahaw	18 Sak	June 3, 353 B.C.	Late Preclassic (400 B.C.–A.D. 200)	Late Formative (400 B.C.–A.D. 100)	Late Formative (400 B.C.–A.D. 100)	Late Formative (400 B.C.–A.D. 100)	Late Formative (300 B.C.–A.D. 300)
7.10.0.0.0	3 Ahaw	13 Pax	July 20, 156 B.C.	Late Preclassic (400 B.C.–A.D. 200)	Late Formative (400 B.C.–A.D. 100)	Late Formative (400 B.C.–A.D. 100)	Terminal Formative (200 B.C.–A.D. 100)	Late Formative (300 B.C.–A.D. 300)
8.0.0.0.0	9 Ahaw	3 Sip	Sept. 5, A.D. 41	Late Preclassic (400 B.C.–A.D. 200)	Late Formative (400 B.C.–A.D. 100)	Early Classic (A.D. 100–500)	Early Classic (A.D. 100–500)	Late Formative (300 B.C.–A.D. 300)
8.10.0.0.0	2 Ahaw	18 Yaxkin	Oct. 23, A.D. 238	Early Classic (A.D. 200–600)	Terminal Formative (A.D. 100–300)	Early Classic (A.D. 100–300)	Late Formative (300 B.C.–A.D. 300)	Late Formative (300 B.C.–A.D. 300)
9.0.0.0.0	8 Ahaw	13 Keh	Dec. 9, A.D. 435	Early Classic (A.D. 200–600)	Terminal Formative (A.D. 100–300)	Late Classic (A.D. 500–600)	Early Classic (A.D. 300–600)	Early Classic (A.D. 300–600)
9.10.0.0.0	1 Ahaw	8 K'ayab	Jan. 25, A.D. 633	Late Classic (A.D. 600–900)	Classic (A.D. 300–950)	Late/Terminal Classic (A.D. 600–900)	Late Classic (A.D. 600–900)	Late Classic (A.D. 600–900)
10.0.0.0.0	7 Ahaw	18 Sip	Mar. 13, A.D. 830	Late Classic (A.D. 600–900)	Classic (A.D. 300–950)	Late/Terminal Classic (A.D. 600–900)	Late Classic (A.D. 600–900)	Late Classic (A.D. 600–900)
10.10.0.0.0	13 Ahaw	13 Mol	Apr. 30, A.D. 1027	Postclassic (A.D. 900–1519)	Postclassic (A.D. 950–1519)	Early Postclassic (A.D. 900–1300)	Early Postclassic (A.D. 900–1300)	Early Postclassic (A.D. 900–1300)

11.0.0.0.0	6 Ahaw	8 Mak	June 15, A.D. 1224	Postclassic (A.D. 900–1519)	Postclassic (A.D. 950–1519)	Early Postclassic (A.D. 900–1300)	Early Postclassic (A.D. 900–1300)
11.10.0.0.0	12 Ahaw	3 Kumk'u	Aug. 2, A.D. 1421	Postclassic (A.D. 900–1519)	Postclassic (A.D. 950–1519)	Late Postclassic (A.D. 1300–1519)	Late Postclassic (A.D. 1300–1519)
12.0.0.0.0	5 Ahaw	13 Sotz'	Sept. 18, A.D. 1618	Postconquest or Colonial (A.D. 1519–1697)	Colonial (A.D. 1519–1821)	Postconquest or Colonial (A.D. 1519–1821)	Colonial (A.D. 1519–1821)
12.10.0.0.0	11 Ahaw	8 Ch'en	Nov. 5, A.D. 1815	Historic (A.D. 1697–1950)	Historic (A.D. 1821–1950)	Historic (A.D. 1821–1950)	Historic (A.D. 1821–1950)
13.0.0.0.0	4 Ahaw	3 Kank'in	Dec. 21, A.D. 2012	Modern (A.D. 1950–present)	Modern (A.D. 1950–present)	Modern (A.D. 1950–present)	Modern (A.D. 1950–present)
13.10.0.0.0	10 Ahaw	18 Kumk'u	Feb. 7, A.D. 2210				
14.0.0.0.0	3 Ahaw	8 Tz'ek	Mar. 26, A.D. 2407				
14.10.0.0.0	9 Ahaw	3 Yax	May 12, A.D. 2604				
15.0.0.0.0	2 Ahaw	18	June 28, A.D. 2801				
15.10.0.0.0	8 Ahaw	8 Pop	Aug. 14, A.D. 2998				
16.0.0.0.0	1 Ahaw	8 Xul	Oct. 1, A.D. 3195				
16.10.0.0.0	7 Ahaw	18 Yax	Nov. 16, A.D. 3392				
17.0.0.0.0	13 Ahaw	18 Muwan	Jan. 3, A.D. 3590				
17.10.0.0.0	6 Ahaw	3 Wo	Feb. 19, A.D. 3787				
18.0.0.0.0	12 Ahaw	18 Xul	Apr. 7, A.D. 3984				
18.10.0.0.0	5 Ahaw	13 Sak	May 24, A.D. 3984				
19.0.0.0.0	11 Ahaw	8 Pax	July 11, A.D. 4378				
19.10.0.0.0	4 Ahaw	18 Wo	Aug. 27, A.D. 4378				
1.0.0.0.0.0	10 Ahaw	13 Yaxk'in	Oct. 13, A.D. 4772				

to the equinoxes and the solstices or zenith and nadir passages in the Middle Preclassic period (1000–400 B.C.). Records of past, present, and future events all incorporate a Mesoamerican calendar based on a repeating cycle of 260 days, employing a set of 20 named days as the basic blocks of time. These 20-day periods are also implicit in architectural alignments that reflect an interest in horizon-based astronomy and landscape features, such as sacred mountains. Some alignments anticipate important solar events at 20- or 40-day intervals, and others mark the position of the sun at 260-day intervals, dividing the year into two unequal parts.

Like Mesoamerican architecture, calendar records from Mesoamerica incorporate “real-time” observations of events in nature; some are keyed to marking important solar dates. The long count calendar traces specific astronomical events back to at least A.D. 143, and it is now apparent that the unique Mesoamerican sacred round calendar of 260 days was used to track eclipses and the Venus cycle in Terminal Formative (A.D. 100–300) epi-Olmec texts (see Justeson, chapter 13, this volume). Other records use repeating cycles of time to project back to mythical events in the distant past or to events far in the future.

In the chapters that follow, the integration of time and space in Mesoamerica is explored through study of the calendrical structure, horizon-based astronomy, and recorded observations of natural cycles, especially those featuring astronomical events. A more detailed discussion of the chapters will help frame the contributions in this volume. Following this introduction, in the second section, “Horizon-Based Astronomy,” authors treat urban planning principles whereby interbuilding alignments and landscape characteristics were used to observe or emphasize movements of celestial bodies. Chapter 2, by Ivan Šprajc and entitled “Pyramids Marking Time: Anthony F. Aveni’s Contribution to the Study of Astronomical Alignments in Mesoamerican Architecture,” emphasizes Aveni’s pioneering role in archaeoastronomy and establishes the book’s theme. A huge corpus of alignment data first collected by Aveni and later augmented by Šprajc is analyzed in light of recent advances in the understanding of the role of astronomy and cosmology in Mesoamerican architectural and urban planning. Šprajc employs statistical analysis to discover the patterns of orientation most prominent in Mesoamerican civic and ceremonial architecture, helping define the primarily solar dates of greatest interest in the alignments evident in architectural orientations throughout Mesoamerica.

The third chapter, “Maya Architectural Hierophanies,” by Anne S. Dowd, explores the role of specific orientations in creating dramatic displays of light and shadow on Maya buildings. A famous example is that of El Castillo pyramid at Chichén Itzá, where the sun illuminates a serpent balustrade on March

20, the spring equinox, and again on September 22, the fall equinox. The range of events displayed in the context of architectural space, such as solstice sunrise and sunset or zenith and nadir passages in Group E-type complexes, is also discussed. This chapter also emphasizes the role of celebrations and observations of solar movements in Maya urban planning and state formation.

The fourth chapter, “Mountain of Sustenance: Site Organization at Dainzú-Macuilxóchitl and Mesoamerican Concepts of Space and Time” by Ronald K. Faulseit, offers evidence of the relationship between landscape features, solar observations, and the seasonal cycle, as expressed in Oaxaca’s Terminal Formative (200 B.C.–A.D. 100). Cerro Danush is a prominent solitary mountain at the northern end of Dainzú-Macuilxóchitl in Oaxaca. In Oaxaca’s Late/Terminal Classic period (A.D. 600–900), its peak was transformed into a temple-patio-altar complex that archaeological evidence suggests was associated with Cociyo, the Zapotec god of lightning, rain, and sky. At the other end of the site, the complex is oriented southwest toward the base of Cerro Dainzú, where carved stone depictions of ball players and jaguar motifs connect it to warfare, death, and the underworld. Faulseit discusses how this contrast of earth and sky domains forms an *axis mundi* that unites the site’s spatial organization with the ritual calendar and the motion of the sun on the horizon.

Part III in this volume, “Cosmological Principles,” focuses on the role of astronomy in Mesoamerican religious iconography, seasonal festivals, and cosmology of world creation and destruction. In chapter 5, “The North Celestial Pole in Ancient Mesoamerica,” Clemency Coggins traces the evolving and adapting calendric role of the Celestial Pole and its personification in Middle and Late Preclassic (1000–400 B.C. and 400 B.C.–A.D. 200) Mesoamerica. As the focus of the layout of many ancient Mesoamerican sites, the significance of the direction north changed through time in some instances, while remaining constant in others, as seen in a persistent association between the concept of north and the face of “God C.” The controversial topic of the Maya understanding of “north” is considered in a long-term context, and this chapter also explores the relationship between the concept of north and Maya images of 7-Macaw, the false sun in the *Popol Vuh*.

The 20-day periods expressed in the 365-day festival calendar are linked with fundamental religious principles in the iconography and cosmology of Postclassic Central Mexico in chapter 6, entitled “A Seasonal Calendar in the Codex Borgia” by Susan Milbrath (see also Milbrath 1999, 2013). This chapter features an eighteen-page narrative in the Codex Borgia with an embedded festival calendar that represents changing seasonal images over the course of a year. Using only calendar dates and cartoon-like images, the Codex Borgia

expresses complex principles that involve “real-time” astronomical events linked with religious imagery, a pattern first explored by Aveni (1999). Rainy-season images include bees, hummingbirds, an abundance of maize and flowers, and a flowered temple that houses the rainy-season Sun God on the summer solstice and fall equinox. In contrast, images of the winter solstice and spring equinox show fire-serpent temples representing the dry season, and generally the dry season is linked with symbols related to war and fire gods. Venus gods also undergo seasonal transformation, helping to explain the multiple manifestations of Venus imagery in the narrative.

The seventh chapter, Gabrielle Vail’s “Iconography and Metaphorical Expressions Pertaining to Eclipses: A Perspective from Postclassic and Colonial Maya Manuscripts,” explores recent research suggesting that the Maya scribes who drafted the Postclassic (A.D. 900–1519) Venus table mapped events from primordial time onto historical dates associated with observations of the planet. The table highlights the Morning Star period of Venus, represented by three separate figures per page: (1) a presiding deity, (2) a warrior corresponding to heliacal rise, and (3) the warrior’s victim. Although presiding deities and victims are Maya in origin, most of the warriors derive from “foreign” sources, including Central Mexico. This chapter examines how the authors of the table adapted ideas and stories from distant places to construct a narrative highlighting events and figures from mythic time.

John B. Carlson’s contribution, “The Maya Deluge Myth and Dresden Codex Page 74: Not the End but the Eternal Regeneration of the World,” (chapter 8), analyzes imagery from a Postclassic Maya codex to lend a new understanding of what had previously been interpreted as a cataclysmic flood event. Instead, Carlson draws upon annual seasonal patterns to suggest simply that the water representation on page 74 of the Dresden Codex indicates the seasonal rains. Rather than world destruction, world renewal is the theme expressed. Carlson’s discussion of floods may be related to some of the points the Brickers have raised in chapter 12, which also refers to torrential rain or flood imagery, from the Dresden Codex.

Part IV, “Calendar Records,” begins with chapter 9, entitled “The Ancient Maya Moon: Calendar and Character,” in which art historian Flora Simmons Clancy treats the role of astronomy in calendar inscriptions and other forms of recording calendar intervals. She discusses Classic period (A.D. 200–900) Maya lunar data known as the Lunar Series. These texts found in Maya in long count inscriptions consist of six to ten glyphs embedded in the long Initial Series date in monumental art. Clancy begins with an analysis of the Lunar Series by looking at monuments bearing the same Initial Series date

but citing different lunar data, and explores the implications for counting by days versus counting by nights. Clancy then examines lunar inscriptions relating to concepts of narrative and iconography in Classic Maya art.

In chapter 10, “Pecked Circles and Divining Boards: Calculating Instruments in Ancient Mesoamerica,” David A. Freidel and Michelle Rich provide a bridge between the calendar reckonings of the Maya and those of Central Mexico. Aveni has long proposed that the lowland Maya adopted important notions of calendar calculation from Teotihuacán. Aveni’s (2005) arguments are based significantly on the correspondence of pecked circles at Teotihuacán and at Uaxactún. Discussing pecked devices along the south side of the Pyramid of the Sun, the authors propose that these may also have been used for divinatory purposes. They link these devices to Classic period Maya representations of tablets and mirrors, suggesting they are calculating devices that are also used for divination and writing.

An early calculating device for the calendar is investigated in chapter 11, entitled “The ‘Las Bocas Mosaic’ and Mesoamerican Astro-Calendrics: ‘Calculator’ or Hoax?” Here Prudence M. Rice studies the calendar intervals expressing an interest in the Venus cycle and other astronomical periodicities that are purportedly incorporated in a unique mirror, attributed to the Middle Formative period (900–300 B.C.) site of Las Bocas in Central Mexico. This chapter explores the calendrical patterns expressed in its mosaic pieces, arranged in three triptych-like panels; the left and center hold 128 tesserae in groupings of four, but the right panel lacks such regular arrangement. Originally thought to have some possible lunar tallying function, this plaque can be used to compute the days of the Mesoamerican 260-day, 365-day, and Venus calendars as well as other significant calendrical intervals. The plaque is either an elaborate hoax or a sophisticated calculation device for calendrical computations. Rice concludes that its uniqueness by no means discounts the possibility that it is authentic, for the accidents of preservation in an archaeological context have resulted in a number of unique objects.

In chapter 12, entitled “Some Alternative Eclipse Periodicities in Maya Codices,” Victoria R. Bricker and Harvey M. Bricker explore a table of possible eclipse cycles based on multiples of the lunar synodic month. Of the twenty-five eclipse periodicities listed, only two appear in the Precolumbian Maya codices. Several tables and almanacs in the surviving codices, however, contain evidence of alternative and apparently culturally more salient eclipse periodicities that commensurate more directly with the 260-day sacred calendar of the Maya (*tzolkin*), even though they are not close to integral multiples of the lunar synodic month.

John Justeson explores the relationship of eclipse occurrence to the ancient Mesoamerican calendar in chapter 13, titled “Modeling Indigenous Meso-American Eclipse Theory.” Justeson traces calendar dates recording eclipses as far back as A.D. 143 in the Veracruz Terminal Formative (A.D. 100–300). The study builds on the well-known correlation of the 260-day cycle with eclipse timing, due to the near equivalence of the span of two divinatory-calendar cycles (520 days) with the time to pass from a node of the eclipse cycle to the third subsequent node (519.93 days). Mesoamericans are not imagined to have had an explicit concept of eclipse nodes; however, by exploring temporal patterns in the timing of lunar eclipses visible in Mesoamerica, this chapter presents a Mesoamerican-type model for eclipse occurrence based on cyclic recurrences in the divinatory calendar, along with a possible reflection in the practices of Colonial Zapotec calendar specialists.

In part V, “Conclusions,” Anthony F. Aveni appropriately gets the “last word” in the final chapter of the volume honoring his legacy. In chapter 14, “Maya Books and Buildings at Baktun’s End,” he synthesizes the major contributions of this volume and also notes other new discoveries, such as the Xultun texts recording Classic Maya tables for tracking the cycles of Venus, Mars, and the Moon (Saturno et al. 2012). Aveni’s chapter sets the stage for future endeavors in archaeoastronomy by highlighting major advances and new directions in research.

Themes that reappear in several of the chapter include the concept of a city as an *axis mundi*, bringing the cosmos into a coherent vertical hierarchy. Other important themes include the city and its plan as a calendar that charts horizontal angles related to the rising and setting of astronomical bodies, number and temporal cycle groupings and intercalation, seasonal correlates of horizontal divisions in the year and spatial divisions in the community or landscape. Also featured is the use of topography in addition to the built environment for astronomical observation or a geomantic perspective, foundations of rulership based upon specialized esoteric knowledge, and other aspects of cultural astronomy or archaeoastronomy.

This volume makes a significant contribution to the understanding of ideas related to symbolism, creation mythology, and spatial organization. It reflects theoretical perspectives ranging from George Kubler’s (1977) reliance upon principles of cultural disjunction to Clifford Geertz’s (1980) rise of the theater state though performative ritual. Micea Eliade (1958, 1959) is cited by a number of the authors on the topics of hierophanies, *axis mundi*, and sacred acts. Although traditionally in Mesoamerica theoretical principles have been only loosely connected to data, this volume gives readers a somewhat stronger

set of relationships between theory and data. For example, in chapter 3 Dowd proposes that a series of tropic relations exist between the part (e.g., a building, or city plan) and a whole (e.g., a cosmogram), drawing upon Terrence Turner's (1991) pivotal efforts in the areas of interactivist or constructivist theory. Faulseit's idea in chapter 4 that a Zapotec city was essentially a world map or a cosmogram can be applied more broadly in our understanding of Mesoamerican urban planning. The complementary opposites of sky-earth, up-down, rainy-dry seasons also leads us back to theoretical principles established by a long line of anthropologists and scholars of religious studies.

By using the calendar and knowledge of mathematics, astronomy, written language, and other modes of cultural and artistic expression, ancient Mesoamerican people were developing prestige technologies. In this sense, the authors of this volume have all described facets of these technologies and are contributing to an anthropological study of technology (Lemonnier 1986, 1992; Pfaffenberger 1988, 1992). This approach, known as the anthropology of technology, explores the ways in which technology is embedded in social, economic, and religious life. Manipulating technology was a means of acquiring or differentiating status that created and maintained social divisions between elites and commoners in Mesoamerican societies. Technology in this theoretical perspective is part of a larger system, one that interpenetrates other cultural subsystems, such as kinship, religion, agriculture, and education. In order to balance the limitations of this form of systems theory, we should consider processes of individual agency and more unique historical trajectories that are accessible when and where written records exist (Dowd 1998a, 1998b).

Brian Hayden (1998) has related prestige technologies to the emergence of social complexity among sedentary hunter-gatherer populations, but understanding the emergence of Mesoamerican primary and secondary states may also be tackled with an anthropology of technology, with special attention to the development of technologies that reinforced social status for the purpose of labor acquisition and control. In addition to hieroglyphic writing, monumental art and architecture, and mathematical and astronomical data incorporated in the calendar, Mesoamerican cultures perfected irrigation technologies and water control systems to support maize agriculture, and trading and lithic technologies surrounding semiprecious jade, and they also integrated performance into religious rituals from a relatively early time period. This suite of elaborate technologies helped attract labor and economically valuable allies to foster community growth. Seen from the standpoint of an anthropology of technology, with a focus upon prestige technologies as catalysts of social change in emerging chiefdoms and states (Redmond and Spencer 2012, Spencer 2010),

Mesoamerican cultural groups created multilayered symbolic representations of their world for the purpose of persuading people to follow their economic, religious, and political points of view through ritual performances uniting communities around common goals and programs, such as the institution of kingship. The authors bring together the kind of information that allows us to see the integration of architecture, the calendar, and social process, all of which form the building blocks for advancing theoretical perspectives.

On a more pragmatic level, our volume could be useful for future analysis of landscape patterns. Although landscape archaeology has not often been explicitly related to the study of Mesoamerican archaeoastronomy in the past, the emergence of Geographic Information Systems (GIS) and the use of Global Positioning System (GPS) coordinates for creating more accurate digital map layers has the potential to transform archaeoastronomy. Three-dimensional mapping using *Light* and RADAR (LiDAR) or digital modeling that includes astronomical data is still in its infancy, but it is a worthwhile goal to model terrestrial spatial data and celestial spatial data simultaneously so that temporal changes can be diagrammed. John Fillwalk (personal communication, 2013) has shown how sophisticated computer graphics can be merged with archaeological, topographic, and astronomical data to produce four-dimensional site models designed to show how the people who built an ancient site used architecture and land and skyscape in modeling their universe. These kinds of GIS or remote sensing applications or computer simulations can be used in archaeoastronomy, producing results that will permit more precise models of architecture, horizon lines, and relationships among rising and setting astronomical bodies. Many of the chapters in this book could potentially contribute to the data employed in GIS or remote sensing techniques designed for the field of archaeoastronomy. Programs such as ArcGIS or ArcINFO now facilitate what were only theoretical possibilities a few years ago.

The contributors to this volume have provided evidence for the concept of a city as a calendar. The overall consensus appears to be that far from a single structure within a community functioning as an observatory, the built environment generally held such a role. Each polity likely created a unique set of topographic patterns that were integrated with natural astronomical cycles so that this astronomical-architectural interaction could be seen as a multi-dimensional calendar. Increasing evidence for interpreting seasonal and agricultural symbolism in the context of urban planning and religious ritual suggests that each time Mesoamerican architects and builders designed a new city, special principles of organization were applied in planning (Ashmore 1991). In this way, the Mesoamerican cultural groups we have studied in this

volume merged technology with social and economic life. We are fortunate to have many new themes available for study in the very near future, building upon the thorough research offered by the authors of this volume.

We have only touched upon theoretical constructs guiding the research presented here on calendars, cosmology and astronomy. Still, connecting theory, method, and data is a worthwhile goal. Having the advantage of written records—in the form of inscribed monuments, codices (or folding-screen books), ethnohistoric accounts dating to just after the conquest, and ethnographies from our era—provides an enormous amount of *emic* (insider), as opposed to *etic* (outsider), information. Given that we have access to the cultural perspective of the groups we are studying, multiple lines of evidence can be used to support many of the authors' conclusions.

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Pyramids Marking Time

*Anthony F. Aveni's
Contribution to the Study of
Astronomical Alignments in
Mesoamerican Architecture*

Mesoamerican archaeoastronomy, including the antecedents of this discipline, has quite a long history. We could start by mentioning Ernst Förstemann's analysis of the Dresden Codex Venus Table and continue with many other attempts to solve the questions concerning Prehispanic astronomically-related cultural manifestations, including the calendrical system, the knowledge and use of various cycles observed in the sky, celestial lore, and architectural orientations. In recent decades Anthony Aveni's work on different aspects of Mesoamerican astronomy has been crucial: he provided a synthesis, still the best one, of what is currently known about multiple manifestations of Mesoamerican astronomical knowledge and related concepts and practices (Aveni 1980, 2001); moreover, in an impressive number of studies, too many to cite here, he has directly contributed to the solution of many specific problems of Mesoamerican astronomy, relying on Prehispanic codices, colonial manuscripts, and hieroglyphic inscriptions.

Written sources, however, had been studied from this point of view for many decades by a number of scholars. Without diminishing the merit of Tony's work in this area of research, I believe his most pathbreaking contribution has been in the field of alignment studies. While there had been isolated attempts at understanding the significance of Mesoamerican architectural orientations, like those by Oliver Ricketson (1928), Ignacio Marquina and Luis Ruiz (1932), Kenneth Macgowan

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(1945), and James Dow (1967), it was Aveni who initiated truly systematic research in this direction. During the 1950s and 1960s, the study of alignments in prehistoric megalithic sites of western Europe, most notably at Stonehenge in England, gave rise to controversies and discussions that ultimately led to the establishment of a new archaeological subdiscipline commonly labeled archaeoastronomy (cf. Aveni 1981; Iwaniszewski 1994a; Ruggles 1999, 1–11). Justly referred to as “the founding father of Mesoamerican archaeoastronomy” (Ruggles and Urton 2007, 3), Aveni effectively introduced this novel field of research to the cultural area of Mesoamerica, adapting the approach developed in the Old World to a context in which the available information was much more abundant and diverse.

What follows is a succinct and inevitably deficient summary of how and to what extent the development of the research of astronomical properties of Mesoamerican architecture and urbanism has been shaped and fueled by Tony Aveni’s work.

FROM INCIPIENT STAGE TO SYSTEMATIC APPROACH

Archaeological explorations in the first half of the twentieth century entailed rapidly increasing knowledge about Prehispanic Mesoamerican architecture, provoking several scholars to think about the possible astronomical significance of alignments they observed in the layout of some prominent buildings. Ricketson (1928), for example, based on earlier observations by Frans Blom (1924), suggested that the alignments embedded in Group E of Uaxactún recorded sunrises on the solstices and equinoxes, and possibly on some other dates whose importance, he believed, was attested in inscriptions; he also associated the sightlines incorporated in the windows of the Caracol at Chichén Itzá with due south, due west, and major lunar standstills. Marquina and Ruiz (1932) noticed two orientation groups in Mesoamerican architecture and related them to the sun’s positions on the horizon on the equinoxes and the dates of its passage through the zenith. Macgowan (1945) recognized the prevalent clockwise skew of Mesoamerican orientations from cardinal directions as well as three different orientation groups. Robert Fuson (1969) discussed possible astronomical referents of orientations, but he also thought that many were laid out to magnetic north.

These and other sporadic studies in the literature served Tony Aveni as a point of departure for his own work. He started by measuring orientations of individual buildings at particular sites and, like his predecessors, tried to find their possible astronomical referents, but the approach of an astronomer was,

from the outset, essentially different. While former studies were based largely on site maps of differing quality, Aveni was aware of technical problems that an assessment of astronomical significance of orientations involved and of the necessity to measure alignments in the field, with theodolite and astronomical fix. With these issues in mind, he published astronomical tables (Aveni 1972), as well as technical background and methodological guidelines for archaeoastronomical work (Aveni 1981), while fruitful collaboration with other scholars, particularly with German architect Horst Hartung, resulted in a number of publications on individual sites and buildings (e.g., Aveni and Linsley 1972; Aveni, Gibbs, and Hartung 1975; Aveni and Hartung 1976, 1978, 1979, 1981, 1988, 1989; Aveni, Hartung, and Kelley 1982; Hartung and Aveni 1982; Closs, Aveni, and Crowley 1984). Data on the solstices, equinoxes, zenith passages of the sun, Venus extremes, and certain stars were now on much firmer ground in terms of the possible astronomical motives underlying orientations of particular buildings and alignments observed in their spatial distribution.

These studies, however, were but a by-product of a much more promising and systematic approach to the study of orientations, which soon resulted in the discovery of broader regularities. Although Marquina and Ruiz (1932), Macgowan (1945), and Fuson (1969) had already recognized the prevalent clockwise skew and clustering of orientations around certain azimuthal values, Aveni collected a larger sample of much more precise alignment data (Aveni 1975, 1977; Aveni and Gibbs 1976). It was now possible to conclude, for the first time with reasonable confidence, that certain orientation groups are widespread in Mesoamerica and that they can be largely accounted for by astronomical considerations, in most cases by sunrises and sunsets on certain dates. This became particularly evident in his first magnum opus based on an impressive corpus of data (Aveni 1980). Here the emphasis was still on what appear to be “naturally” significant solar phenomena, like solstices, equinoxes, and zenith passages; much fewer were the orientations possibly related to Venus extremes and certain stars or asterisms.

In a later monograph focused on the Maya area, Aveni and Hartung (1986, 7–8) wrote: “The astronomical hypothesis would seem especially worthy of consideration if we find alignments that are confined to a narrow azimuthal range in a sample of buildings spread far apart in space. In this case, there can be no conceivable way of actually laying out the chosen direction other than by the use of astronomical bodies at the horizon as reference objects.” Even if they cautiously stressed the need for considering multiple orientation factors of which astronomy may have been but an integral part, the evident clustering of certain azimuths on their histograms based on a large data sample

represented a very strong indication that the prevalent targets of orientations in the Maya area were, indeed, the rising and setting points of celestial bodies.

CONTEXT AND MEANING

From the very beginning, however, Aveni was aware of the inadequacy of a purely quantitative approach, as was commonly employed in the early alignment studies in the Old World. His interpretations, supported with contextual evidence, illustrate his belief, substantiated in several theoretical discussions, that the significance of architectural orientations can be properly understood only in the light of the natural setting, subsistence strategies, religion, and other aspects of culture of the society that produced them (e.g., Aveni 1980, 1981, 2001; Aveni and Hartung 1986). In a particularly extensive and thought-provoking reflection on methods and aims of archaeoastronomy, Aveni (1989) exemplified some fundamental questions that should lie at the core of any archaeoastronomical inquiry if the place that this interdisciplinary endeavor deserves within anthropology is to be secured: “What is the nature of the relationship between astronomical phenomena and cultural behavior? What did astronomical phenomenon X mean to the people who practiced it? Why were they interested in phenomenon X instead of Y? How did they conceive of that phenomenon in their ritual, myth, calendar, religion, architecture and historical chronology . . . ? What role did it play in shaping their ideology?” (Aveni 1989, 6–7). In short: “What were they up to and why?” (Aveni 1989, II). Rather than merely establishing a possible relationship between an alignment and an astronomical event, we should ask why this phenomenon could have been significant to a given society.

While proposing “an anthropology of astronomy,” Aveni also called attention to the fact that, beside astronomical ones, there may have been many other orientational motives, and he warned of the fallacies derived from ethnocentric prejudices. Although similar initiatives for sound methodology and theoretical constructs were formulated—with differing focuses, details, and recommendations—by various scholars (e.g., Reyman 1975; Broda 1993, 2000; Iwaniszewski 1989, 1991, 1994a, 1995; Ruggles and Saunders 1993; Ruggles 1999; Milbrath 1999; Carlson et al. 1999), it was, indeed, both surprising and laudable that the plea for an emphatically anthropological approach came, at such an early stage, from an astronomer! Quite obviously, Tony managed to overcome the limitations that he, indulgently, ascribed to natural scientists: “How can an engineer who has never taken an anthropology course be expected to address questions about whether astronomical knowledge was public or

private, much less a part of hierarchical power relations? A better question might be: how can an engineer who has never read a book about the culture, whose alignments he/she measures to the nearest arc minute, even make a meaningful statement about indigenous astronomy?" (Aveni 1992, 1).

In their study on the Maya area briefly referred to above, Aveni and Hartung (1986) made notable progress in interpretations, suggesting that the alignments marked sunrise and sunset dates separated by multiples of 20 days from the dates of the sun's passage through the zenith, and these observations were significant in the calendar because they were associated with agricultural scheduling. The proposal made sense in the light of both environmental peculiarities and cultural context: multiples of 20 days would have made observational calendars easy to handle by means of the formal calendrical system, and the most frequently recorded dates were consistent with the rainfall pattern and agricultural cycle in the Maya lowlands. While the idea was not entirely new—orientation calendars with such characteristics had been formerly proposed in relation with the alignments at Copán (Merrill 1945; Aveni 1977) and Teotihuacán (Drucker 1977)—Aveni and Hartung (1986) argued that the use of observational schemes composed of calendrically significant intervals must have been a rather general practice among the Maya. A follow-up of this study was focused on Preclassic (2000 B.C.–A.D. 200) sites, mainly those located along the Pacific Coast (Aveni and Hartung 2000).

Parallel work of other scholars, particularly Franz Tichy, resulted in similar conclusions. Tichy (1974, 1976, 1983) analyzed orientations of Prehispanic temples and Colonial period (A.D. 1519–1821) churches in Central Mexico; even if his alignment data were derived from maps, their amount and distribution clearly showed the existence of several orientation groups. According to this author, whose complex hypotheses are exhaustively presented in a later monograph (Tichy 1991), the dates recorded by orientations tend to be separated by calendrically significant intervals (multiples of 20 and 13 days), but he also argued that their distribution reflects the use of a geometric scheme based on 4.5° angular units.

Several studies that soon followed drew heavily upon Aveni and Tichy's work. Possible observational calendars, including also sunrise or sunset dates marked by prominent mountain peaks on the local horizon, were proposed for particular sites (e.g., Peeler 1989; Broda 1993; Galindo Trejo 1994, 2000; Iwaniszewski 1994b; Morante López 1993, 1996; Šprajc 1990, 1995). Other hypotheses also appeared. To cite but a few examples, basing his studies on maps, Malmström (1978, 1981, 1997) associated numerous architectural alignments (often involving prominent mountaintops) with the solstices, whereas

for another common Mesoamerican alignment group, skewed about 15° north of west, he claimed it referred to sunsets on August 13, commemorating the date of the beginning of the long count in the Maya area. Ponce de León (1982) connected Central Mexican architectural orientations with solar positions on the shifting dates of the New Fire ceremonies over time, in the absence of a leap year in the Aztec calendar. In contrast, some authors argued that a fixed correlation of the formal calendrical year with the year of the seasons is evidenced in orientations pointing to sunrises on February 12, which they maintained was the beginning of the year given by Sahagún (Galindo Trejo 1990; 1994, 129; Broda 1993; Tichy 1991).

ADVANCES IN METHODOLOGY

Although these and other interpretative attempts made use of data about the Mesoamerican calendar, astronomy, and related concepts, a frequent problem was the lack of any direct or demonstrable relationship between architectural alignments and the evidence adduced. In the absence of specific references concerning orientational rules, it is difficult to ascertain which information, if any, has a bearing on understanding this practice. No wonder, then, that even the same orientations were interpreted in different, often mutually exclusive ways. Even Motolinía's (1971, 51) famous statement, clearly relating the orientation of the Templo Mayor of Tenochtitlan with the sun's position on a particular date, is liable to different interpretations (Aveni, Calnek, and Hartung 1988; Šprajc 2000). Motolinía's comment does indicate the existence of the practice of orienting important buildings with respect to solar positions on certain dates, but it involves ambiguities concerning the exact date and the details about the position of the sun in relation with the temple and the observer.

Another problem was inherent in the extant body of alignment data. If the orientations referred to sunrises and sunsets on specific dates—opinion shared by various hypotheses mentioned above—they must have recorded these dates with accuracy. In many cases, however, the interpretations relied on deficient and low-precision alignment data, which made any confident conclusion impossible.

One difficulty was that the azimuth of a line measured at a building was commonly considered to represent the orientation of the whole structure. Since most buildings have rectangular ground plans (or are composed of rectangular elements, incorporating lines that are roughly parallel and perpendicular to each other), these data were highly revealing as to the determination of *approximate* orientations, and sufficiently exact to allow the discovery

of azimuth distribution patterns and *orientation groups*, most clearly through Aveni's work. Nonetheless, the azimuths determined this way were not appropriate for more detailed considerations because they may not be representative of the intended architectural orientations and certainly lacked the accuracy required for testing diverse hypotheses that were put forward on the basis of these data.

It is well known that many Mesoamerican buildings have patently rhomboidal ground plans. In these cases it is obvious that the orientation of a structure cannot be described with a single azimuth; in other words, it is unlikely that north-south lines of a building can be considered as indicative of its orientation in the east-west direction, and vice-versa. If, for example, the base of a stairway in the north-south direction is measured, the perpendicular to this line can hardly be considered as corresponding to the structure's east-west axis, because the latter could be laid out rather by columns, pillars, wall faces, or other construction elements that marked the desired astronomical direction with much greater precision than the imaginary perpendicular to the stairway. It thus seems much more natural to relate astronomical events on the eastern or western horizon to architectural east-west lines than to nonexistent perpendicularly, whose relationship with these phenomena is not directly manifest or easily observable.

Another deficiency in the available data was that generally only azimuths were published, without the corresponding horizon altitudes. The coordinate that allows identification of the astronomical phenomenon possibly related with an alignment is the declination, which depends not only on the azimuth but also on the geographical latitude of the observation point and the horizon altitude along the alignment.

Finally, not every line preserved at a building is equally relevant. Though we can only imagine possible observational practices, it is reasonable to suppose that the alignments intended to be observationally functional were laid out with particular care in the upper parts of a building. Hence the walls of upper sanctuaries, or axes of symmetry indicated by their entrances, should be considered as representing the intended orientation much more accurately than, say, the faces of supporting platforms.

Even though some of the problems mentioned above characterize Aveni's data as well, it is only fair to underline that, when he initiated his pioneering work, the astronomical significance of Mesoamerican architectural orientations was only a matter of speculation. At that point it was necessary to establish with certainty whether astronomical motives were at all involved, and for that purpose the methodology he applied was, in comparison with former

approaches, a huge step forward, leading to the recognition of pervasive patterns for which the astronomical rationale was the most viable one. It was largely his work that prompted different interpretational hypotheses, but the latter, in turn, served as feedback information disclosing deficiencies in data collection procedures shared by various researchers as well as the need for further fieldwork with different approaches. This represents a concrete example of what was expressed long ago, and in a more general context, by David Thomas (1979, 448): “We cannot help but note how frequent synthesis and reflection—even if incorrect—serve to stimulate additional fieldwork, and these new data generally serve as the basis for reinterpretation and modification.”

Taking into account the above-mentioned problems and other facts that had not been recognized before, a more elaborate methodology was applied in a study of architectural alignments at a number of archaeological sites in Central Mexico. For assessing the hypotheses about horizon calendars, not only the orientations of civic-ceremonial structures but also the directions to prominent peaks on the local horizon, placed within the angle of annual movement of the sun, needed to be measured. The subsequent analyses of the alignment data showed that the dates of sunrises and sunsets both along the architectural orientations and above the prominent hills on the local horizon tended to be separated by multiples of 13 and 20 days. The regularities detected led to the conclusion that both the architectural orientations and the prominent local horizon features allowed the use of observational calendars composed of calendrically significant intervals; furthermore, the distribution of the most recurrent dates in the tropical year suggested that these observational schemes served—as formerly argued for the Maya area (Aveni and Hartung 1986)—for facilitating an efficient scheduling of the agricultural activities and the corresponding rituals (Šprajc 1999, 2001).

Aveni et al. (2003) reached analogous conclusions for the Petén area in their study of a special type of Maya architectural assemblages resembling Group E at Uaxactún, Guatemala. Their analysis, based on a statistically significant and typologically homogenous sample of alignments, led them to substitute a previous hypothesis, which interpreted the greater part of these assemblages as nonfunctional imitations of the (astronomically functional) Group E of Uaxactún (Aveni and Hartung 1989), with new findings that the alignments reflect the use of observational schemes composed of calendrically significant intervals. In agreement with what had been suggested for Central Mexico (Šprajc 2001), they also noted that the most frequently recorded dates suggest the importance of anticipatory sun sightings during the dry half of the year leading up to the planting season (Aveni et al. 2003, 163; Aveni 2003, 161–62).

Further support to these interpretations has been provided by a recently completed collaborative study in the Maya lowlands. Field measurements at eighty-seven sites have resulted in alignment data for over 250 civic and ceremonial buildings. In this case several statistical analyses have also been performed. The declinations corresponding to the east-west versus north-south azimuths have been shown to exhibit significantly different distributions: according to the results of the Kolmogorov-Smirnov test, the east and west declinations differ from those calculated from randomly selected azimuths and horizon altitudes in a much greater degree than the north and south declinations, leading us to suggest that the orientations were functional primarily in the east-west direction. In the analysis of declinations corresponding to the east-west azimuths, individual errors estimated on the basis of uncertainties of azimuths and horizon altitudes were assigned to each calculated value; to sum up these data, declination frequency plots were developed with peaks representing the values targeted by particular orientation groups with reasonable confidence.

Upon a determination of the dates corresponding to the declination peaks within the solar span, it has become apparent that at least one of the intervals delimited by the sunrise and sunset dates recorded by each of the most prominent orientations groups represents a multiple of 13 or 20 days. From a comparison of the degree of concentration/dispersion of declinations corresponding to each orientation group on both horizons, it was assumed that the more pronounced clustering indicates the direction in which the orientation group was observationally functional; the directionality determined in this way was in agreement with the direction that the orientation group marked as a calendrically significant interval. It is thus highly likely, also on statistical grounds, that the orientations were intended to record dates separated by multiples of 13 and 20 days (Sánchez Nava and Šprajc 2011a, 2011b; Richter and Šprajc 2011; Šprajc et al. 2011).

This research in the Maya area has led to another interesting result: several orientations have been identified that closely correspond to major lunar standstills, but this is again something that had been anticipated by Tony Aveni. For the Castillo at Paalmul, on the northeastern coast of the Yucatan Peninsula, Aveni and Hartung (1978, 11) observed that its orientation could be related to major lunar standstills, and added that the Moon cult was very important in this area. Indeed, most of the potentially lunar alignments that we have detected are located precisely along the northeastern coast of the Yucatán Peninsula, including the island of Cozumel (Šprajc 2009; Sánchez Nava and Šprajc 2011a; Šprajc et al. 2011), which is known to have been a very popular

Postclassic (A.D. 900–1519) focus of pilgrimages associated with the worship of the goddess Ixchel, whose lunar attributes are indisputable (Milbrath 1999).

For some orientations, the present state of the buildings' conservation makes it difficult to decide whether they refer to lunar standstills or Venus extremes, which were another celestial target explored by Aveni (1975; Aveni, Gibbs, and Hartung 1975; Aveni and Hartung 1978). Although contextual evidence that might give priority to one or another interpretation is often missing, one case, which has long been known, is rather clear: the Governor's Palace at Uxmal has a plethora of references to Venus in its iconography. Aveni (1975, 183–87; Hartung and Aveni 1982; Aveni and Hartung 1986, 22–23) related the orientation of this structure to the southernmost rising point of Venus as Morning Star, while my own interpretation links the alignment to the great northerly extremes of the Evening Star (Šprajc 1993, 45–47; 1996, 173–78; Bricker and Bricker 1996). As already commented on elsewhere (Šprajc 2005, 212–13), our disagreement concerns only final details of our proposals and derives from giving different weights and interpretations to particular types of contextual evidence; only future research, looking for more comparable alignments and other relevant information, may resolve these differences.

PROBLEMS AND PROSPECTS

In sum, Tony Aveni's work represents a cornerstone of Mesoamerican alignment studies. If, as I trust, the new alignment data collected with improved methods and techniques summarized above enable us to uncover the builders' intentions much more accurately and reliably than before, it is also clear that these advances in methodology would not have been possible without previous work, in which Tony's contribution was essential. His research was fundamental for the recognition of patterns attributable to astronomical factors, and his ample corpus of data represented the most inviting source for different interpretative attempts. As the number of scholars engaged in the alignment studies grew, so did the diversity of interpretations, which soon showed that, in order to verify them, more rigorous data collection procedures were needed. On the other hand, Aveni's general theoretical guidelines remain incontrovertible and have had a profound impact on the study of astronomical properties of Mesoamerican architecture and urbanism. Even though we have made great progress, the following attempt at a summary shows that a number of problems persist; some of them are, unfortunately, a consequence of ignoring general theoretical principles, many of which were formulated long ago by Aveni, while others are research questions that can eventually be solved.

Aside from the studies already referred to above, a large number of other alignment studies focusing on particular Mesoamerican sites or buildings have been published in recent decades. The list is long, and a literature review with pertinent citations is beyond the scope of this paper. Nonetheless, in the attempt to find some common characteristics of these studies, I would say that some of the resulting interpretations are congruent with the prevailing patterns revealed by the above-mentioned analyses of large samples of alignment data, and add significant details to our understanding of these alignments, while others are rather unique, often referring to stars and constellations. Particularly problematic seem to be the hypotheses about the astronomical significance of sightlines connecting diverse architectural elements of a single structure, because no coherent methodology has been developed that would allow, in the absence of supporting contextual evidence, an objective assessment of the validity of such ideas in the light of comparative data. For alignment studies to achieve compelling results, the alignments of this kind would need to be classified on the basis of some objective typological criteria: if astronomically significant patterns were recognized in arguably homogenous data sets (cf. Hawkins 1968, 49), their intentionality would be demonstrated.

Regularities can be revealed only by systematic research based on a number of sites that manifest some degree of cultural homogeneity, but this approach also has some shortcomings that seem inevitable: in the study of diverse sites, it is impossible to pay sufficient attention to the whole complexity of each one; clearly, detailed research at one site can detect more elements of potential astronomical significance and generate important new hypotheses, but these need to be verified by comparative investigations. It can be concluded that both approaches are necessary and complementary, each of them having certain advantages and limitations.

Many particularistic alignment studies are still flawed by imposing modern Western-minded templates on data selection and interpretation. As cautioned by a number of scholars, including Aveni (1989), such preconceptions distort the objectivity of research results and prevent a global comprehension of the complexity of astronomical and other factors involved in orientation practices. An example of prejudices of this kind is the significance assigned *a priori* to certain moments of the tropical year, such as the solstices and equinoxes, which even in serious publications—particularly those of generally archaeological nature—continue to be highlighted as the most important (if not the only) solar phenomena targeted by Mesoamerican architectural orientations. In fact, the most widespread alignment groups disclosed by systematic research accomplished so far indicate a much greater importance of other

dates, notwithstanding regional and time-dependent variations. Although the solstitial orientations are relatively common, the evidence for Prehispanic significance of (true astronomical) equinoxes is remarkably scanty, not only in architectural alignments (cf. Aveni, Dowd, and Vining 2003, table 1; Šprajc 2001; Sánchez Nava and Šprajc 2011a, 2011b; Šprajc et al. 2011) but also in Maya epigraphic records (Nikolai Grube, personal communication, 2011).

As summarized in the previous section, we can be quite certain about the existence of orientation patterns based on astronomical and calendrical considerations, but our current interpretations of their meaning and social role are much less satisfactory and secure. The relevance of the evidence associated with the buildings in question (iconography, small archaeological finds) for interpreting their orientations is difficult to establish, aside from the fact that this evidence can often be interpreted in many different ways and thus does not lend definitive support to a single astronomical hypothesis. Nonetheless, more specific evidence may exist, and the Governor's Palace of Uxmal seems to be a good example, as noted above; hence the search for such data should not be abandoned. Furthermore, to verify the idea that the orientations are largely related to agricultural concerns, study of the alignment patterns needs to be integrated not only with regional rainfall patterns and other environmental constraints, but also with ethnographically documented agricultural practices. A comprehensive study of local ethnographic data on agricultural scheduling and related ceremonies may be highly revealing, particularly if continuity from Prehispanic times can arguably be assumed (cf. Milbrath 1999, 12–17).

There are a number of other questions that have not been answered in a satisfactory way. How were the astronomically derived motives underlying architectural design and urban planning combined with nonastronomical precepts? What was the nature of the relationship between observational function and symbolic significance of astronomically oriented buildings? If practical needs were, indeed, important motives for astronomical observations, how were they interrelated with religion, rituals, and political ideology? What observational techniques were employed? How can we explain regional and time-dependent variations in orientation patterns? Do they reflect environmental differences, long-term climate changes, cultural idiosyncrasies, and/or significant turning points in cultural development? And, inversely, can similarities observed over extensive areas tell us something about cultural interaction in particular periods?

By attempting to answer such questions, future archaeoastronomical studies can contribute substantially to the solution of broad and generally interesting archaeological problems. For pursuing these objectives, I believe we have not

only a large amount of information we have not yet fully used but also a solid theoretical foundation and an adequate—though continuously developing—methodology, much of which we owe to Anthony F. Aveni.

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ANNE S. DOWD

Ancient people used architectural space to track the movement of heavenly astronomical bodies and, in the process, create hierophanies. In particular, where and when is visual information dramatized by the hierophantic play of light and shadow on Maya buildings? A famous example can be seen at the Castillo pyramid at Chichén Itzá, where the sun illuminates a north serpent balustrade on March 20–21, the spring equinox, and on September 21–22, the fall equinox. The building may have been built to commemorate the close of the tenth baktun, 7 Ahaw 18 Sip, on March 13, A.D. 830 in our Gregorian calendar (Coggins 1987, 427; Krupp 1997, 267; Stuart 2011, 242). This baktun ending fell a week before the spring equinox.¹ The range of events displayed in the context of architectural space, such as solstice sunrise and sunset or solar zenith and nadir passages in Group E-type complexes, will be discussed to show how and why agents, architects, or audiences observed and celebrated solar movements in urban planning.

INTRODUCTION

The Maya merged astronomy with social life, using architectural hierophanies to reinforce and highlight solar events on days that were propitious for political and religious reasons. In the context of ritual performances, such natural light displays on architectural backdrops focused the viewer's attention, creating a sense of urgency and agency, which dramatized the

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synergy of natural and human forces controlling world events related to agricultural production and timing. Sunlight on architectural façades illuminated temple entrances or sculptured wall panels and manifested patterns of light in temple interiors on days or times of the day that were key solar events in the seasonal cycle, such as the summer or winter solstices, spring or fall equinoxes, and zenith or nadir passages. These astronomical-architectural displays held agricultural, calendrical, political, and religious meaning for the Maya. Through performance, art and architecture amplified social power.

A hierophany may be a targeted display of light and shadow against the backdrop of art and architecture. Geometric ideals in urban plans or other designs have also been considered visible sacred signs or religious revelations. Possibly, converging temporal cycles were also seen this way, posing a more explicit relationship between science and religion than is understood in our own culture. Mircea Eliade (1958, 11; 1959) calls hierophanies a physical manifestation of the sacred. Hierophanies in Maya city centers anchor the agricultural seasons and timing of planting and harvest to political strategy and religious ritual through astronomical observation. Architectural alignments refer to structural plan orientations, like centerlines, or window or doorjambs that might have been used to emphasize planetary or other astronomical risings and settings above the horizon. Interbuilding alignments refer to two or more building elevations that provide a sightline for an astronomical event, like sunrise or sunset.

The body of theory that provides the context for the research presented here comes from discussions of the rise of the theater state (Christie 1985; Geertz 1980, 46; Schoenfelder 2003, 94). More specifically, the theoretical perspective of tropes offered by the interactivists or constructivists guides my research on the Maya city, architectural complex, or building as a cosmogram where a part substitutes for the whole (Turner 1991). Architectural orientations compiled using archaeoastronomical and standard surveying principles provide a methodological basis for my analysis. Contemporary ethnographic practice of sun worship at dawn on the winter solstice and eight specific examples of winter solstice hierophanies in the Maya region provide information about how traditional Maya people might have viewed the passage of time at the longest night of the solar year.

During one of my first trips to Mesoamerica, I witnessed a New Year's celebration on the west coast of Guatemala, on the black sand beaches of Las Lisas. With another of Tony Aveni's students, I had gone there to escape the noise in Guatemala City, where many fireworks, or *bombas*, were being set off in anticipation of New Year's Eve. We arrived in this sleepy little hamlet,

relieved that all was quiet and peaceful, had a *guarro*-infused drink in a coconut under a *palapa* on the beach, and retired to our hammocks early. Imagine our surprise when around midnight it appeared that the rest of Guatemala had followed us there. We awoke to a full-on beach party, with radios blasting, drunken teenage boys staring down at us, and entire families sitting on blankets facing the ocean in the dark, waiting for the sun to rise. What had been a quiet empty beach when we went to sleep had been transformed into a noisy, crowded, trash-littered free-for-all by morning. In retrospect, this was a mix of ancient and modern traditions, or syncretism, with the completion of one cycle and the expectation or hopeful anticipation of the next. People gathering to watch the horizon at dawn on the New Year, waiting to see the sun rise again and a new cycle of time begin, provides us with an alternative world view, one in which the dawn of a new cycle is just as important, if not more so, than the end of the old year at midnight. After all, what is sunrise but the ultimate hierophany, as dawn breaks to reveal the world man and nature have created?

Another example of an event that begins at midnight is the “Dance of Martín” documented at Santiago Atitlán, a lakeside Maya community in Guatemala (Christenson 2006, 94). The ceremony is performed annually at midnight on November 10. Other rituals, some coinciding with the winter solstice and celebrated at midnight, have been documented for the Southwest, Central Mexico, and other parts of the world.² In the context of the Dance of Martín, the dance itself may be envisioned as a clock that resets time, allowing performers to circle back to begin again.

The winter solstice, which is a turning point when the rising sun reaches its maximum southerly position, marks some architectural hierophanies in the Maya area. Using ethnographic analogy, perhaps the morning after the winter solstice may be compared to the December 31–January 1 celebration that I witnessed on the beach before sunrise. Using the widely but not universally accepted 584,283 variant of the Goodman-Martinez-Thompson (GMT) correlation, the thirteenth baktun end fell on winter solstice sunset, December 21, or sunrise on December 22. Here I will explain the length of the 13 baktun interval in terms of the solar cycle. A baktun (144,000-day/400 calendar round year group) completion date occurred in the Maya calendar cycle on 13.0.0.0.0 4 Ahaw 3 K'ank'in. This was the conclusion of the thirteenth baktun—each baktun was equal to 20 katuns equaling 20 tuns or 7,200 days each, or 400 *tuns* total, each one a set of 360 days, when referring to cycles of time.³ Using a 365.2422-day solar year, thirteen baktuns (394.26 years each) total 5,125.37 years. Some calculations suggest that the Maya estimated 365.255- or 365.242-day solar years (Aveni 2001, 165).

Because this baktun-ending date is really a subcycle of a larger count of time (Justeson 2010, 51; Morley 1915, 117–18; Stuart 2011, 236–67), calendar adepts or religious specialists may have equally projected the baktun end as the beginning of a new cycle in 2012. The point is that, like the solstice as the passage from one temporal cycle to another, it was a succession of time in the calendar. One ancient Maya ruler from Tortuguero speculated about his hypothetical role when he became an ancestor at the close of the thirteenth baktun far in the future. Ruler Bahlam Ajaw's investiture of a god named Bolon Yokte' K'uh is described on Monument 6 of Tortuguero on that date (Gronemeyer and MacLeod 2010, 42; see also Chapter 7). In our own culture we talk about turning the pages of history, and the Maya imagined folding a screen prophecy book. Metaphors about time can help us comprehend what repetitive seasonal transitions may have meant.

To understand the true significance of the history of solstice events, we now turn to study of the role of archaeoastronomical alignments in ancient Maya architecture. Research at Calakmul shows that one place to look for light and shadow effects in architectural settings is within the complexes that resemble Group E at Uaxactún, a complex long known to be aligned to horizon extremes of the sun (Blom 1924, 56–60; Ricketson 1927). My research expands upon earlier efforts to understand Group E-type complex variability in Maya centers, where each one appears to have been custom-made for the topography and unique site settings in which they were built (Aveni et al. 2003; Dowd and Aveni 1998; Dowd et al. 1995; Dowd 2015). In other words, originality was prized over uniformity. Since I was first introduced to the topic, over 160 archaeological sites have been identified with Group E-like complexes and about 20 percent have been excavated and reconstructed (Freidel et al., forthcoming). These sites represent a robust data set for understanding the relationship between urban planning and the calendar.

HISTORIOGRAPHY OF HIEROPHANY

This next section focuses on architectural hierophanies and offers some interpretations about how they functioned and why they were constructed. First, let us review hierophanies roughly in terms of their type and when they first were described in the literature, referring mainly to the Maya region but also adding some cross-cultural examples. Then we may evaluate known architectural hierophanies at fourteen Maya centers in terms of the specific event(s) highlighted (table 3.1). I suggest that, like numerology and poetics (Dowd 1998), the Maya rather enjoyed creating clever displays of architectural light and shadow and that such visual effects will be recognized more frequently

TABLE 3.1. Maya Architectural Hierophanies (winter solstice hierophanies are in bold type)

<i>Site</i>	<i>Complex</i>	<i>Building</i>	<i>Date</i>	<i>Event</i>	<i>Audience Day</i>	<i>Time of Age/Period</i>	<i>Ruler</i>	<i>Hierophany</i>
Blue Creek	Quincunx	Chultun, east of Structure I	June 21, May 12, and August 2	Summer solstice, zenith passage	Private	Noon	Late Classic	Person's shadow aligns with chultun opening
Calkmul	Group E-type	IV c	1995	June 21, summer solstice	Public	Sunset, 6:00 p.m.	Late Classic A.D. 649-810	Rulers Structure IVc central (only) doorway lit by sun setting behind Structure VI, shadows are parallel with Structure IVc doorjambs Yuknoom Chi'en II, Yuknoom Yich'aak Kahlk, Split Earth, Yuknoom Took' K'awill
Calkmul	Group E-type	IV c	Dec. 21	Winter solstice	Public	Sunrise, 5:00 a.m.	Late Classic A.D. 649-810	Interbuilding alignment as seen from Structure VI stela platform Rulers 3-6, e.g., Yuknoom Chi'en II, Yuknoom Yich'aak Kahlk, Split Earth, Yuknoom Took' K'awill

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TABLE 3.1.—*continued*

<i>Site</i>	<i>Complex</i>	<i>Building</i>	<i>Date</i>	<i>Event</i>	<i>Audience</i>	<i>Day</i>	<i>Time of Day</i>	<i>Age/Period</i>	<i>Ruler</i>	<i>Hierophany</i>
Chichén Itzá	Radially symmetrical	El Castillo	Sept. 22	Autumnal equinox	Public	Afternoon	10.0.0.0.0	Multiple	Shadows cast on balustrade to create triangular shadows like the undulating body of a serpent	
Chichen Itzá	Osario	June 21	Summer solstice		Various	10 Ahaw 18 Sip, Mar. 13, A.D. 839, Late Classic	7 Ahaw 18 Sip, Mar. 13, A.D. 839,	Multiple	Shadows cast on balustrade to create triangular shadows like the undulating body of a serpent	
Copán	Main Plaza	Stela D	June 21, Sept. 21–22, Dec. 21, Mar. 20, May 1, Aug. 13	Equinoxes, Public solstices, zenith Dec. 21, passage Mar. 20, May 1, Aug. 13	Various	9.15.5.0.0 10 Ahaw 8 Chen, July 24, A.D. 736 (a.k.a. 18 Conejo/ Rabbit)	Waxaklahun Ubah Kawil (a.k.a. 18 Conejo/ Rabbit)	Multiple	Stela D functions like a gnomon or sundial casting shadows on adjacent stairways	
Dzibilchaltún	Group E-type	Temple of the Seven Dolls (1-sub)	Sept. 22	Autumnal equinox	Public	Sunrise	9.13.0.0.0 8 Ahaw 8 Wo, March 18, A.D. 692, Late Classic or Early Period II		Sun shines through main doorway as viewed from causeway, stela platform, or Structure 66	

Dzibilchaltún	Group E-type	Temple of the Seven Dolls (I-sub)	Mar. 20	Vernal equinox	Public	Sunrise	9.13.0.0.0 8 Ahaw 8 Wo, March 18, A.D. 692, Late Classic or Early Period II
El Mirador	Group E-type	3D _{3-1,2,3}	Dec. 21	Winter solstice	Public	Sunrise	Middle-Late Preclassic
Ikil		Cave 1	Mar. 20	Zenith passage	Private	Sunrise, 8:01 a.m.	Late Classic Multiple
Mayapán		El Castillo	Dec. 21	Winter solstice	Public	Sunset 6:00 p.m.	Postclassic Multiple
Oxkintok		El Satunsat or El Laberinto	Mar. 23-24	Vernal equinox (canonical)	Private	Sunset	Late Classic, A.D. 622
Oxkintok		El Satunsat or El Laberinto	Sept. 20-21	Autumnal equinox (canonical)	Private	Sunset	estimated Late Classic, A.D. 622

Interbuilding alignment

Ikil: Interbuilding alignment from Cave 1 to Structure I

Mayapán: Shadows cast on balustrade to create shadows

Oxkintok: Connection with GII of Palenque Triad?

Notes:

Dzibilchaltún: Sun shines through main doorway as viewed from causeway, stela platform, or Structure 66

El Mirador: Interbuilding alignment from Cave 1 to Structure I

Ikil: Interbuilding alignment from Cave 1 to Structure I

Mayapán: Shadows cast on balustrade to create shadows

Oxkintok: Nine windows or slots allowing light into interior spaces (e.g., in Rooms 11, 12)

Oxkintok: Nine windows or slots allowing light into interior spaces (e.g., in Rooms 11, 12)

continued on next page

TABLE 3.1.—*continued*

<i>Site</i>	<i>Complex</i>	<i>Building</i>	<i>Date</i>	<i>Event</i>	<i>Audience</i>	<i>Day</i>	<i>Time of Age/Period</i>	<i>Ruler</i>	<i>Hierophany</i>
Palenque		Palace Tower	June 22	Summer solstice	Private	Sunset	Late Classic, eighth century		T- or "Ik"- shaped window lets in sun-light in this shape on opposite wall inside structure on the summer solstice at sunset
Palenque		Temple of the Inscriptions	Dec. 23	Winter solstice	Public	Sunset	Late Classic, A.D. 688	K'inich Janab Pakal (a.k.a. Pacal)	Interbuilding alignment from House E
Palenque		Temple of the Inscriptions	June 21	Summer solstice	Private	Sunset	Late Classic, A.D. 688	K'inich Janab Pakal (a.k.a. Pacal)	Interbuilding alignment through side windows with the Temple of the Cross
Palenque	Cross group	Temple of the Cross	Dec. 21	Winter solstice	Private	Sunset	Late Classic, A.D. 692	K'inich Kan Bahlam (a.k.a. Chan Bahlum II)	God L on eastern sanctuary door-jamb illuminated
Palenque	Palace	Stela I	June 21	Summer solstice	Public	Sunset	Late Classic	K'inich Kan Bahlam (a.k.a. Chan Bahlum II)	Stela I illuminated
Palenque	Cross group	Temple of the Sun	May 7, Aug. 5	Zenith	Private	Sunrise, 8:00 a.m.	Late Classic, A.D. 692	K'inich Kan Bahlam (a.k.a. Chan Bahlum II)	Slivers of light enter temple interior

Palenque	Cross group	Temple of the Sun	Mar. 21	Equinox	Private	Sunrise, 6:50 a.m.	9.13.0.0.0	K'inich Kan Bahlam (a.k.a. Chan Bahlum II)	Slivers of light enter temple interior
Palenque	Cross group	Temple of the Sun	Jan. 29, Nov. 9	Nadir	Public	Sunrise	Late Classic, A.D. 692	K'inich Kan Bahlam (a.k.a. Chan Bahlum II)	Central doorway lit
Palenque	Cross group	Temple of the Sun	June 21	Summer solstice	Private	Sunrise, 9:15 a.m.	Late Classic, A.D. 692	K'inich Kan Bahlam (a.k.a. Chan Bahlum II)	Slivers of light enter temple interior
Tulum									
Uaxactún	Group E	E-VII-sub, E-I, E-II, E-III	Jun. 21	Summer solstice	Public	Sunrise	Late Preclassic-Early Classic, A.D., 278	Divine God sculpture inside temple lit	Interbuilding alignment from E-VII-sub

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TABLE 3.1.—*continued*

<i>Site</i>	<i>Complex</i>	<i>Building</i>	<i>Date</i>	<i>Event</i>	<i>Audience</i>	<i>Time of Day</i>	<i>Age/Period</i>	<i>Ruler</i>	<i>Hierophany</i>
Uaxactún	Group E	E-VII-sub, E-I, E-II, E-III	Sept. 22	Autumnal equinox	Public	Sunrise	Late Preclassic— Early Classic, Stela 18 and 19 = 8.16.0.0.0 3 Ahaw 8 Kank'in A.D. 97, Stela 20 = 9.3.0.0 2 Ahaw 18		Interbuilding alignment from E-VII-sub
Uaxactún	Group E	E-VII-sub, E-I, E-II, E-III	Dec. 21	Winter solstice	Public	Sunrise	Late Preclassic— Early Classic, A.D. 278		Interbuilding alignment from E-VII-sub
Uaxactún	Group E	E-VII-sub, E-I, E-II, E-III	Mar. 20	Vernal equinox	Public	Sunrise	Late Preclassic— Early Classic, A.D. 278		Interbuilding alignment from E-VII-sub
Watna (Güiro)	Group E-type	G _{31,30}	Dec. 21	Winter solstice	Public	Sunrise	Middle—Late Preclassic		Interbuilding alignment
Yaxchilán		33	June 21	Summer solstice	Private	Sunrise	Late Classic, A.D. 741	Bird Jaguar IV	Sun illuminates Bird Jaguar IV portrait (full round sculpture) inside structure
Yaxchilán		40	June 21	Summer solstice	Public	Sunrise	Late Classic, A.D. 741	Bird Jaguar IV	Central doorway lit
Yaxchilán		41	June 21	Summer solstice	Public	Sunrise	Late Classic, A.D. 741	Bird Jaguar IV	Central doorway lit

as buildings are excavated, reconstructed, and evaluated by scholars who are trained to look for these phenomena. The groupings of summer/winter solstice (55 percent), spring/fall equinox (28 percent), and zenith/nadir passage (17 percent) of the examples discussed in this chapter may roughly divide into seasonal celebrations: e.g., winter solstice/nadir passage/spring equinox (40 percent) or summer solstice/zenith passage/fall equinox (60 percent). These seasonal dates are not only documented in architectural alignments, but they also have been correlated with dry (November–April) or wet (May–October) seasons in the codices (tables 3.2, 3.3), as described by the other authors in this volume (e.g., Milbrath in chapter 6). Geraldo Aldana's (2002, 38–41) work on *k'älaj k'in* Sun binding or *k'alk'in* solar period completion ceremonies may also pertain to my interpretation because they relate to cycle beginnings, endings, and 20-day interval divisions as shown by Copán's Stela 23 hieroglyphic text as well as related Valley stelae placement and dates.

Light effects, dances or processions following patterns like the Dzibilchaltún Structure 1-sub *graffito* 1, and music, chanting, and patterned speech, numbers, or song with poetic or prayer-related linguistic features may have accompanied festivals and rituals in plazas or other ceremonial spaces (figure 3.1; Coggins 1983, 39; Dowd 1998, 31). Just as increasing poetic density in spoken chants or visual media signaled the climax of a sacred event (Dowd 1998, 31), natural light spotlighting a person or key sculpture within a temple entrance might have similarly created drama, momentum, and a sense of expectation for audiences. By poetic density, I mean gradually adding poetic devices until the sacred ritual events reached a crescendo marking the transition from secular to sacred, both in space and in time. Controlled displays of sunlight would have been an especially effective multidimensional technique for reinforcing the idea that a ruler was the living embodiment of the Sun on earth, and the progression of light may have punctuated participation in a ritual circuit. For example, as the illumination/shadow effects descended to form a silhouette of a serpent body on the balustrade on El Castillo at Chichén Itzá, a procession might have moved down the stairway in time with the event, toward the cenote or another point along a ritual path. The 364 steps (91 per stairway) may be both an architectural and a processional manifestation of seasonality.

GROUP E-TYPE COMPLEXES

The first example of an architectural hierophany was recognized at Uaxactún in the now famous Group E complex, where solstice and equinox sunrises may be observed from a western structure (EVII-sub) facing three structures (E-I,

TABLE 3.2. Solar Hierophanies

<i>Event</i>		<i>No.</i>	<i>%</i>	<i>Subtotals (%)</i>
Solstice	Summer	11	32	55
	Winter	8	23	
Equinox	Spring (Vernal)	5	14	28
	Fall (Autumnal)	5	14	
Passage	Zenith	5	14	17
	Nadir	1	3	
		35	100	100

TABLE 3.3. Seasonal Divisions (Dry/Wet)

<i>Dry</i>		<i>No.</i>	<i>%</i>	<i>Subtotals (%)</i>
Solstice	Winter	8	23	
Passage	Nadir	1	3	
Equinox	Spring	5	14	
		14	40	40
<i>Wet</i>				
Solstice	Summer	11	32	
Passage	Zenith	5	14	
Equinox	Fall	5	14	
		21	60	60
Total		35	100	100

E-II, E-III) on the east side (figures 3.2, 3.3; Aveni and Hartung 1989, 441–43; Blom 1924, 56–60). On the December solstice, the sun rises over the southernmost corner of E-III as viewed from the middle of Structure E-VII-sub's second-stage platform and sets over E-I's northernmost corner, and the trajectory reverses on June 21 (Aveni et al. 2003, 161). Detailed examination of excavated and reconstructed Group E-type complexes may yield unique hierophanies at different sites. As noted elsewhere (Dowd et al. 1995, 9), “it would be interesting to see if Temple III at Uaxactún, skewed from the underlying platform alignment to face E-VII-sub, operates like the illuminated doorways (with doorjamb shadows lining up) of Temple IVc at Calakmul on summer solstice sunset.” Other events, like zenith passages at Calakmul on approximately May 10 or August 3, but variable elsewhere based on site latitude, and intervals that are multiples of 20 days, were observed in the Group E-type complexes that were featured at many Maya sites (Aveni et al. 2003, 159, 162–63, 171).

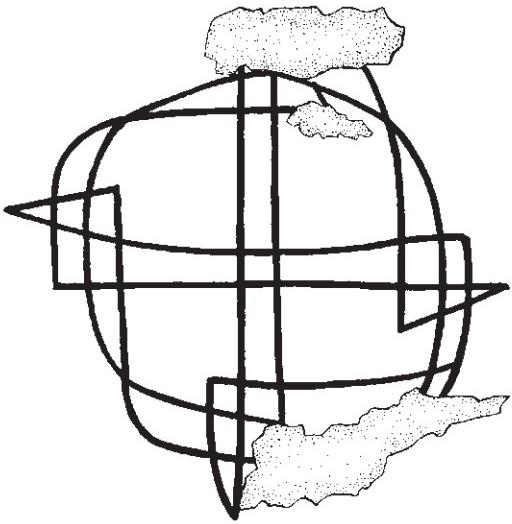


FIGURE 3.1. Graffito 1 from Structure 1-sub Temple Floor, Dzibilchaltún (Coggins 1983, 39; reprinted with permission).

Information has been reported about one of Calakmul's hierophanies within a Group E-type complex in the center's main plaza (figures 3.4–3.6a, b):

... the original doorway within Structure IVc, oriented 286° , would have had the summer solstice sun shining directly on it, but the shadows cast by the doorjambs would not have been parallel to the summer solstice sunset azimuth. Perhaps it was this observation that inspired the architects to place the doorway of the antechamber, added on to the original one-room construction, on the building's central axis, so that the shadows cast by it would bracket the offset inner passage. Thus, the second construction phase created a pair of doorways oriented 294° . This orientation lines up perfectly with the last gleam of the sunset on the June 21 summer solstice ($294^\circ\ 02'$). (Dowd et al. 1995, 4)

Other potential hierophanies exist at Calakmul, where at the Group E-type complex, identified in the 1940s and excavated in 1995 (Carrasco V. 1999; Carrasco V. et al. 1995; Carrasco V. et al. 1996; Ruppert and Denison 1943, 19), we found deviations from expected alignments of only a couple of degrees and a clearly marked winter solstice sunrise, looking from the stela platform on axis with Structure VI (western structure) to Structure IVc (eastern structure) (Dowd et al. 1995, 8, 16). The winter solstice is the time and direction for commemorating the dead, and the double-headed serpent plus K'awil or God K were prominent in associated ceremonies (Tate 1992, 114, 135).⁴

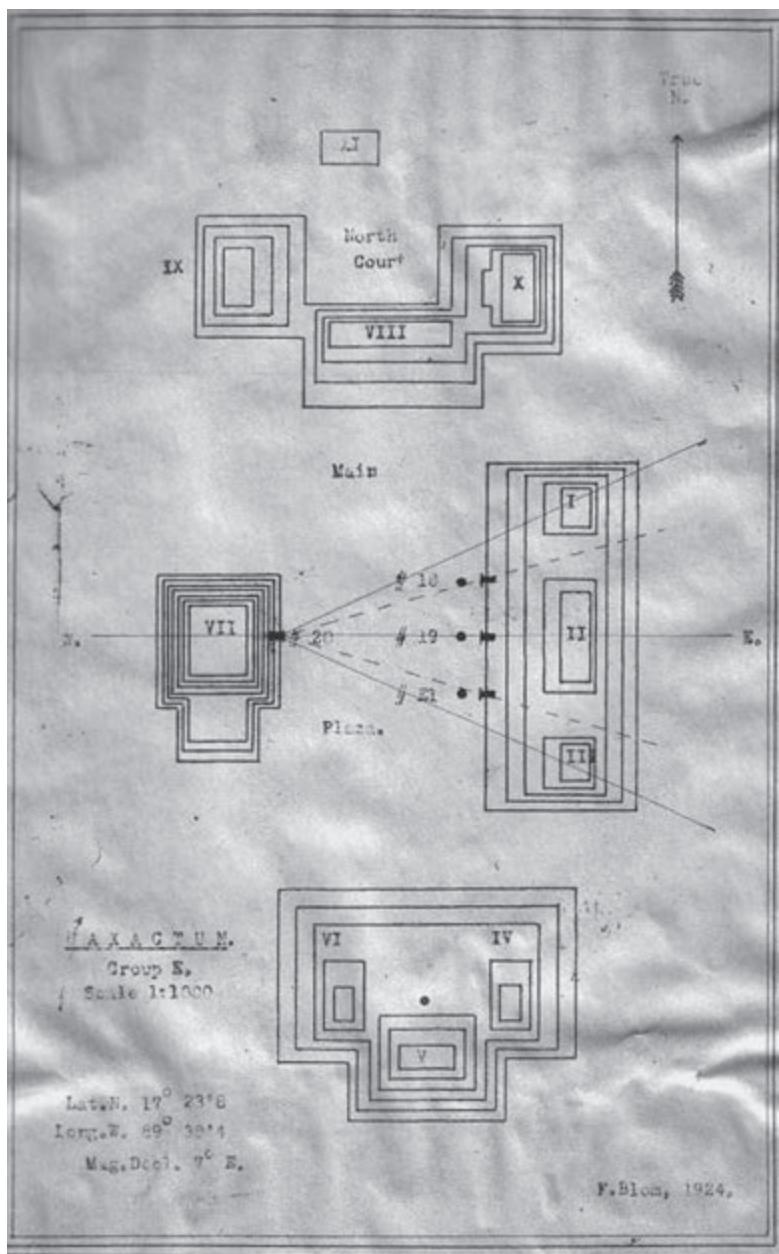


FIGURE 3.2. Group E plan, Uaxactún (illustration by Frans Blom [Blom 1924, 58]; courtesy of the Peabody Museum of Archaeology and Ethnology, Harvard University).



FIGURE 3.3. Line from east to west over Stela 18 to Stela 20 and Mound VII at Uaxactún (photograph by Frans Blom [Blom 1924, 59]; courtesy of the Peabody Museum of Archaeology and Ethnology, Harvard University).

At El Mirador, a Group E-type complex also has an eastern structure oriented with the winter solstice in the El Tigre architectural complex, dating to the Middle or Late Preclassic period (1000 B.C.–A.D. 200) (Aveni et al. 2003, 165; Dahlin 1984; Graham 1967, 43–41; Hansen 1990; Matheny 1980, fig. 2). Similarly Wakna's (also known as Güiro) Structures G₃₁ and 30 in the E Group are aligned with the winter solstice (Aveni et al. 2003, 168; Graham 1967, fig. 27; Hansen 1993). Hierophanies on the winter solstice within the temple superstructures may have complemented these interbuilding alignments. As has been shown in our review of Group E-type complexes in the Maya region, overall the orientations at different sites vary, but as a group the alignments initially cluster around solstices and later on zenith-based 20-day uinal intervals measured along the horizon become more important, turning the city centers into giant sundials (Aveni et al. 2003, 171). They functioned as four-dimensional calendars, measuring the tropical year's 20-day “monthly” intervals rather than the sun's hourly positions, as do many European sundials. We know from Central Mexican ethnohistory and manuscript studies that the eighteen *veintena* festivals form 20-day divisions of the year that have structural parallels with Maya uinals (DiCesare 2009; Wisdom 1940).

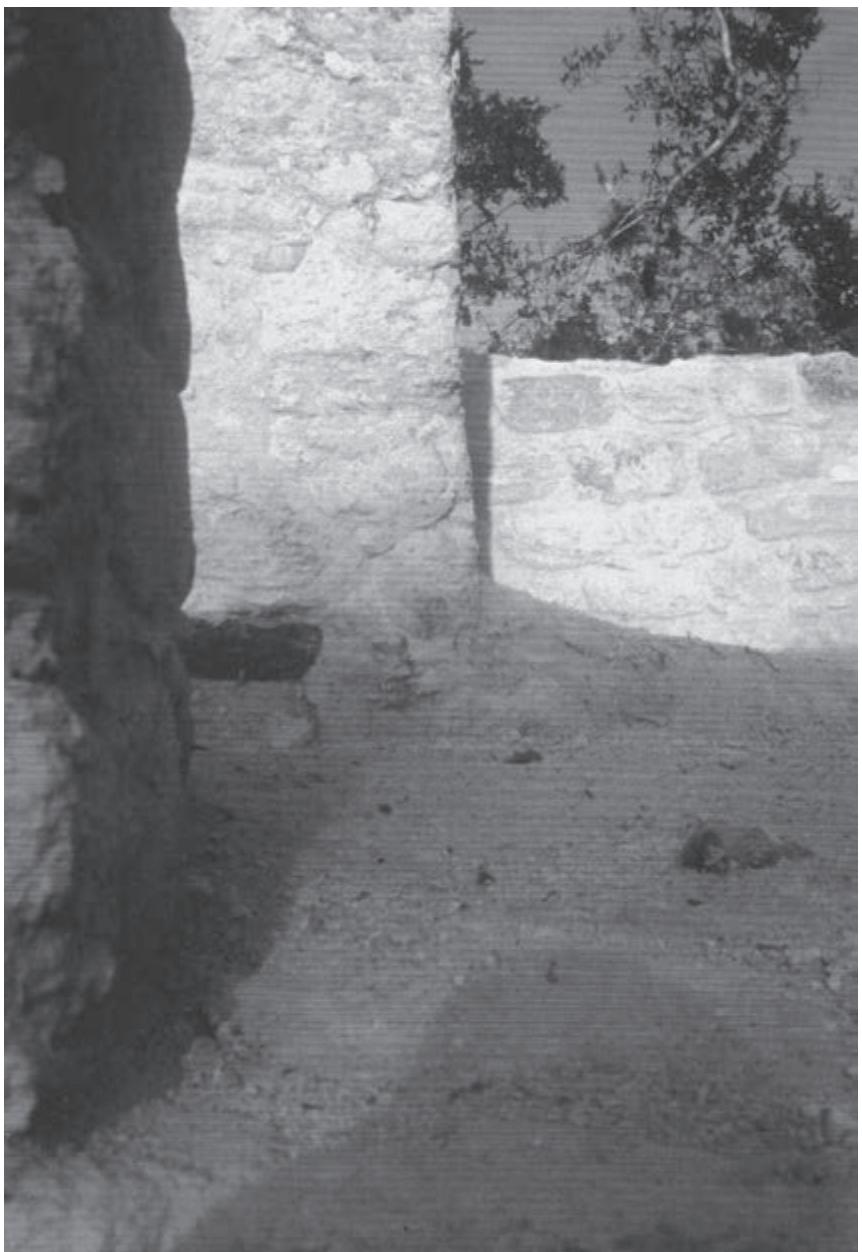


FIGURE 3.4. *Structure IVc doorway, Group E-type complex at Calakmul, Mexico, sunset, summer solstice, view east (photograph by Anne S. Dowd, © 1995, all rights reserved).*



FIGURE 3.5. Calakmul's Structure IVb, east side of Main Plaza, the central structure of the E Group (Benavides C. et al. 2007, 59; image courtesy of Grupo Azabache, S.A. de C.V., Mexico City; artwork by Omar Acero and Enrique Gutiérrez Barrios).

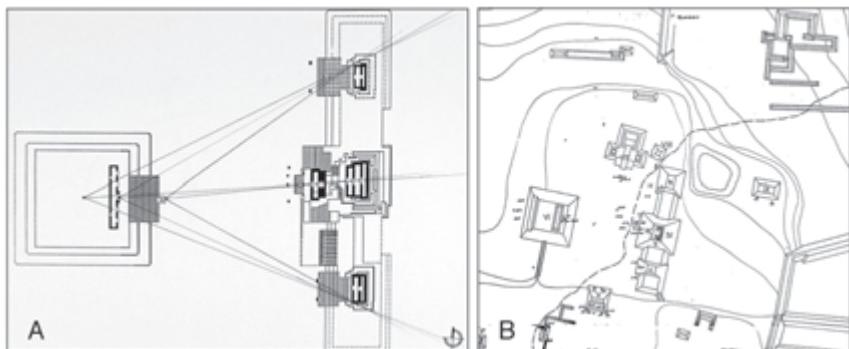


FIGURE 3.6. (a) Plan of Calakmul Group E-type complex, post-excavation (modified after Carrasco V. et al. 1995, drawing by E. González); (b) map of Group E-type architectural complex (Structures VI, IVa, b, c) at Calakmul, pre-excavation (Ruppert and Denison 1943, plate 61; courtesy of the Peabody Museum of Archaeology and Ethnology, Harvard University).

RADIAL STRUCTURES

The late northern Maya lowland pattern of radially symmetrical structures may have had ties to much earlier Group E-type antecedents in the southern Maya lowlands.⁵ Radial structures are another building category for which light and shadow phenomena have been recognized. El Castillo at Chichén Itzá is a superb example (Arochi 1976; Carlson 1999; García-Salgado 2010, 121; Gilpin 1948; Krupp 1982, 12–13; 1983, 298; 1991, 96–99; 1996, 59–61; 1997, 267–68; Rivard 1971, 3, 7; Šprajc and Sánchez Nava Pedro 2013, 41–47). Excavated in the 1930s, the structure displays a serpent body shadow created by seven light angular terrace edges that becomes visible on the equinoxes (vernal, March 20–21, and autumnal, September 21–22) in the afternoon, 4:30–5:30 p.m. at least an hour before sunset, as Jean-Jacques Rivard observed, based on a photograph taken by Wilbert Torres Campos on September 21, 1970. Early photographs taken by Gilpin (1948) showed the phenomenon for the first time. The shadow aligns with a serpent head at the base of the north stairway, the main stairway, whereas the other three stairways neither have serpent heads at their bases nor have apparent hierophanies (figure 3.7). Rivard (1971, 2) suggested that an associated ritual was performed and that its significance might be linked to the equinox, the region of North, and the feathered serpent, noting also that color symbolism may have come into play.

In addition, the orientation of the structure in line with the Sacred Cenote, or Cenote of Sacrifice, may have been important in ceremonies. The sun highlights the feathered serpent symbolizing Quetzalcoatl, an avatar of Venus that “descended” from heaven to go into the cenote, a passage to the underworld or the nighttime sky. Today people from all over the world congregate in the spring at Chichén Itzá to see this equinoctial event, so its effectiveness in engaging viewers remains as compelling as it was in Precolumbian times. The Temple of Kukulcan at Mayapán also has a visible hierophany in a structure modeled on El Castillo at Chichén Itzá, but it coincides with the winter solstice, as Luis E. Arochi recognized (Aveni et al. 2004; Brown 2005, 390–91; García-Salgado 2010).

Another radial structure in Yucatán is found at Dzibilchaltún, where the Temple of the Seven Dolls (Structure 1-sub) on the plaza’s east side has a doorway in line with the western Structure 7, which is oriented to sunrise a few days before the spring equinox (Chan Chi and Ayala Garza 2003; Coggins 1983, 7; Coggins and Drucker 1988, 24; Tenreiro and Victor 1982). According to Clemency Coggins (1983, 7), Jose Guadalupe Huchím Herrera and Victor Segovia Pinto reported that they observed sunrise through the four doorways at the autumnal equinox. From the newspaper account and accompanying



FIGURE 3.7. Sketch of *El Castillo* made by Jean-Jacques Rivard from original photograph taken September 21, 1970, 4:30–5:30 p.m. (Rivard 1971, fig. 3; reprinted with permission).

photographs, it would appear that observers stood due west of Structure 1-sub and about 50–100 m west of Structure 12, the stela platform near the center of the Seven Dolls Group terrace (Tenreiro and Victor 1982).

Structure 1-sub is a radially symmetrical pyramid resembling the Maya completion sign in plan view, and it is decorated with a quadripartite frieze illustrating the watery underworld from which a tower, possibly representing the world tree, emerged. Coggins (1983, 36) wrote: "It served to put man and his constructed environment in harmony with celestial phenomena, created an instrument for measuring these phenomena, and thus made it possible to predict their behavior though the use of the calendar which in turn dictated the timing of prophetic and celebratory cyclic completion ritual." The Temple of the Seven Dolls (Structure 1-sub) is part of a Group E-like complex formed with Structures 4–9 to the west—in other words, with a single structure in the east and three structures to the west, a layout opposite to that of Group E at Uaxactún.

The landscape itself may provide the earliest models for solar hierophanies, such as those seen in caves. For example, at Ikil a cave mouth frames a view of sunrise at 8:01 a.m. from behind Structure 1 at the site on days of the sun's

zenith passages, May 23 and July 20 annually (Slater 2012). The first zenith passage in May closely approximates the beginning of the rainy season and the time for sowing crops (Aveni et al. 2003; Slater 2012). Structure 1, a transitional Late Classic/Postclassic (ca. A.D. 900) construction, has eastern and western doorways aligned to the sun's horizon locations at the solstices, somewhat like Structure 1-sub's doorways oriented with the equinoxes at Dzibilchaltún (Aveni 1980, 313; Coggins 1983, 57; Slater 2012). Another example is at the Quincunx Group at Blue Creek, where a hierophany seems to take place inside a Late Classic (A.D. 600–900) chultun during solar zenith passage (Zaro and Lohse 2005, 93, 95).

Tulum's Temple of the Diving God (Structure 5) has a beam of light that shines through an eastern window illuminating the area under the Diving God at sunrise on the winter solstice (Iwaniszewski 1987, 209–12; Paxton 2001, 118). The presence of similar windows in El Castillo at Tulum, which is associated with a cave, like Ikil, or a cenote in the cases of Mayapán, Dzibilchaltún, and Chichén Itzá (Paxton 2001, 119; Slater 2012). Merideth Paxton (2001, 97, 117, 141–42) suggests that Tulum represented the direction of winter solstice sunrise relative to a center point at Chichén's Castillo and compares this with the overall cruciform plan rendered in the Madrid Codex on pages 75–76. In addition, Tulum's original name of the site, Samal (or Zamá), has been interpreted as "City of the Dawn." One can imagine ancient pilgrims journeying to the site to witness winter solstice sunrise at Tulum in line with Paxton's (2001, 96, 116) idea that Tulum symbolized the direction of the winter solstice sunrise in relation to Chichén Itzá.

OTHER STRUCTURES

Other structures in the Maya area or features in other regions also have displays of light and shadow on key dates. At Oxkintok the Labyrinth or Satunsat building contains nine slot windows that line up with the sun's position—for example, sunset close to the equinoxes—to permit light inside the structure on certain days (figure 3.8; Ferrández Martín 1990; Sprajc 1990, 91, 96; 1995). Those date spans, March 18–April 3 or September 9–25, roughly correspond with uinals marking intervals between the equinoxes. Light penetrating the room interiors created private hierophanies used for timekeeping, ritual activities, or both at once. This structure functions in a manner reminiscent of the light "daggers" illuminating spiral petroglyphs framed by standing stones at Fajada Butte, New Mexico, at important solar or lunar extremes (see also figure 3.12; Sofaer et al. 1979, 290). Chichén Itzá's Caracol and Copán's Structure



FIGURE 3.8. Oxkintok's *Satunsat* building, West Façade, with numbered slot windows or wall openings (photograph by Ivan Šprajc [Šprajc 1990, 88]; reprinted with permission).

22 also have similar functions with respect to Venus horizon extremes (Aveni 1984, 28).

Architects and archaeologists working in Palenque have reported a series of hierophanies in the Temple of the Sun, also the Temple of the Cross and the Inscriptions, clustering on dates such as the solstices and zeniths or nadirs (figure 3.9; Aveni and Hartung 1978, 173–74; Anderson et al. 1981, 35–36; Anderson and Morales 1981, 30, 32; Hartung 1976; Mendez et al. 2005; Schele 1974, 1979, 49–51).⁶ The Temple of the Inscriptions lines up with the summer solstice sunset azimuth (Hartung 1976). On the summer solstice, sunlight passes through an *Ik*-shaped window in the Palace Tower (Anderson and Morales 1981, 35–36). At winter solstice sunrise a ruler standing in the main doorway in the Temple of the Sun would have been fully illuminated (Aveni 1992, 66; Carlson 1976, 110), but the actual alignment of the central panel is to the solar nadir. This is just one of many solar alignments recognized by Alonso Mendez and his colleagues (Mendez et al. 2005, 55). It is probably not a coincidence that the extremely well preserved Temple of the Sun displays such a range of architectural hierophanies. We may look for these in other examples of intact art and architecture across the Maya region. For example, María Cristina Pineada de Carías et al. (2009, 2013) have interpreted Copán's Stela D as a gnomon or part of a sundial (figure 3.10a, b).



FIGURE 3.9. Sunlight on God L panel, Temple of the Cross, Palenque (Schele 1979, fig. 4.4; reprinted with permission). The dashed line would have been the height of the sun's light on the panel when the entrance was intact.

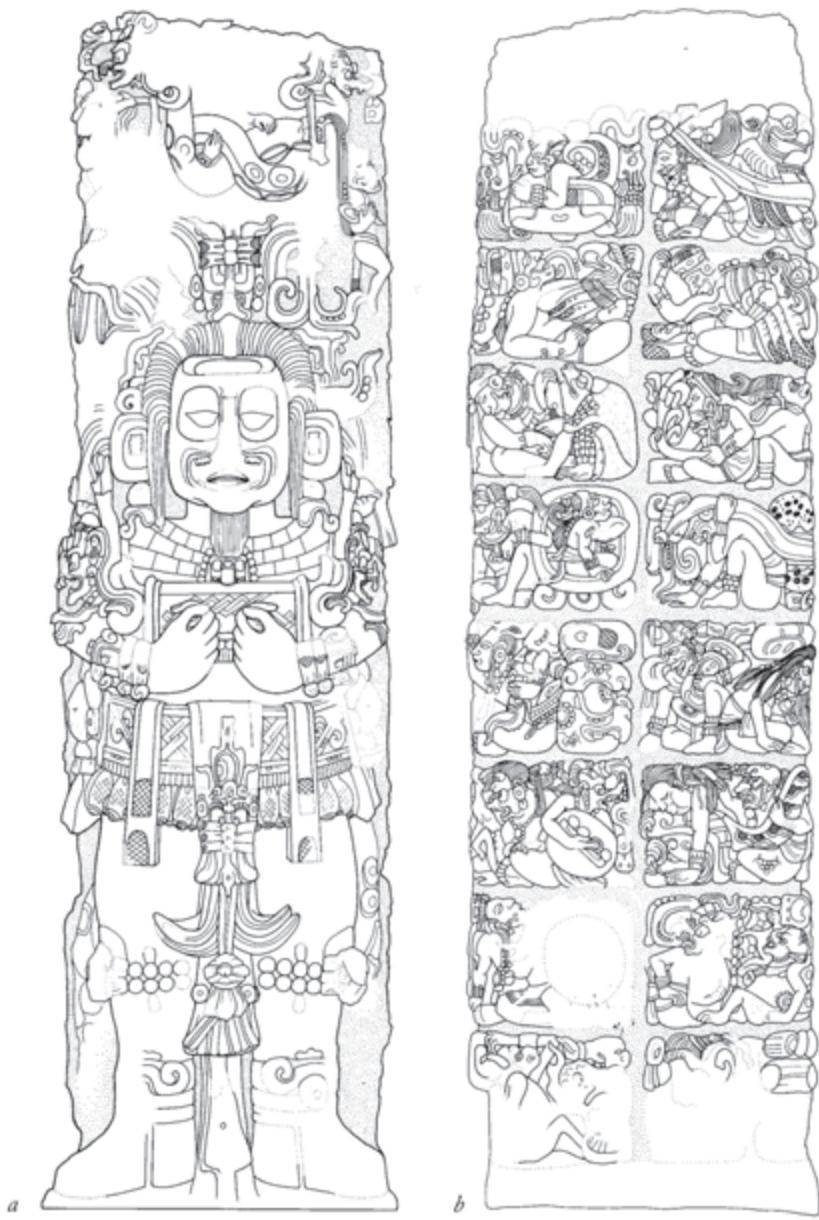


FIGURE 3.10. Stela D, Copán, CPN 7, 9.15.5.0.0 10 Ahaw 8 Ch'en, July 22, A.D. 736: (a) south side; (b) north side (illustrations by Anne S. Dowd [Baudez 1994, 39], courtesy of Instituto Hondureño de Antropología e Historia [IHAH]).

An illuminated statue and at least two other architectural hierophanies have been reported to exist at Yaxchilán (Tate 1985; 1986, 180, 183–85; 1989, 417–19, 425; 1991; 1992, 95, 107, 113–14, 221, 240; also see the critique by Iwaniszewski and Galindo Trejo 2006, 20 or Bricker and Bricker 2011, 686–690). The sun shines on Bird Jaguar's sculpted portrait in Structure 33's central doorway during the morning of the summer solstice, but the date is not reflected in the 9.16.6.0.0 dedication record (Tate 1992, 224).⁷ Structures 40 and 41 have central doorways that are also supposed to be illuminated by summer solstice sunrise. The shape of the lit doorway and surrounding shadows at Yaxchilán prompted Carolyn Tate (1992, 95, 144) to comment on the presumed relationship between a quatrefoil symbol and summer solstice.⁸ Furthermore, Rachel Egan (2011, 97) asserts, "the ruler's placement within the quatrefoil denoted their ability to enter the nexus of the universe to conduct rituals." This symbolism relates to the flapstaffs on Yaxchilán stelae, which display quatrefoil motifs that may represent portals between natural and supernatural worlds, cave or cenote entry, and by extension temple doors. The flapstaff dance ceremony may have been performed on the summer solstice and on period endings, accessions, captures, and sacrifices of living kings (Grube 1992; Looper 2003; Tate 1992, 114). Although Mark Wright (2011) notes that royal accession dances are relatively rare in Maya iconography, according to Sandra Noble Bardsley (1994, 90), "Bird Jaguar was claiming that his succession was as inevitable and important as the solar succession at summer solstice, but it appears that Chan Bahlum II of Palenque should be credited with the specific linking of summer solstice to dynastic rites of passage."

Mathew Looper (2003) concludes that Classic period (A.D. 200–900) Maya dances were timed to the division of the year at the solstice and marking the return of the rainy or second planting season, but Stanislaw Iwaniszewski and Jesús Galindo Trejo question this conclusion because *canícula* most often starts at the end of July, about a month after the June solstice. Iwaniszewski and Galindo Trejo (2006, 20) also question the buildings Tate (1992) uses as examples of hierophanies, overturning the hypothesis that the solsticial alignments were significant at the site. They disagree with Tate's measurements, which differ from their own measurements done in 2001 (Iwaniszewski and Galindo Trejo 2006, 19–21). For example, Iwaniszewski and Galindo Trejo (2006, 20) believe that Tate's measurements of the axis of Structure 33 are off by at least 11°, causing the sunlight on the summer solstice to illuminate only part of the sculpture inside Temple 33's central entrance. Iwaniszewski and Galindo Trejo (2006, 21) also conclude that all of Tate's (1992) measurements were sufficiently approximate that Structures 20, 21, 33, 40, and 41 did not line up with summer solstice morning light.

Because Tate's (1985, 1986, 1989, 1991, 1992) emphasis on hierophany incorporated into Yaxchilán's city planning sparked interest among other researchers, the results of those arguments are summarized above in the interest of providing details that future researchers may use in evaluating both these arguments. Horizon line variability, such as the height of the surrounding topography, changes the angle of the sunlight as it rises or sets, so hierophanies should be observed in the field in addition to measuring horizontal alignments. Precise measurement combined with field observation helps strengthen the case for an astronomical alignment or hierophany.

OTHER REGIONS

Zenith sun sighting “tubes” or observatories exist in Monte Albán in Structure P and Xochicalco in a cave, and may exist at Chichén Itzá in the Osario building (Anderson 1981, 24; Krupp 1997, 269; Milbrath 1999, 63–64; Morante López 1995, 47, 55, 60). These tubes permit the sun to enter a vertical hole from April 29–30 to June 21 (52–53 days) at Xochicalco, and a similar phenomenon takes place between April 17 and the summer solstice (65 days) in the zenith tube at Monte Albán (Milbrath 1999, 63–64). Hierophanies are part of a widespread pattern of attention to solar and astronomical phenomena, developed to a high art in the displays of light and shadow not only in Maya buildings but also in other parts of the world.

Aveni's published work has inspired this kind of research in the Maya region (e.g., Milbrath 1999, 190). Aveni is cited in nearly every study that appears in the bibliography for this chapter, and his work has prompted examination of similar phenomena in other regions. An example is Melvin L. Fowler's (1996, 39, 56) analysis of tenth- and eleventh-century Lohmann phase Woodhenge 72 at Cahokia, with its circle of forty-eight wooden posts, likely used for observing solstice and equinox sunrises and sunsets. As with Group E-type complexes in the Maya region, associated burials suggest that it served to unite corporate kin group members in a central place, connecting a lineage with the earth below and the sky above, or an *axis mundi*.

A comparison may be made with the use of petroglyphs or other rock art panels in the Southwest and their locations in areas where big men or chiefs held ceremonies highlighting agricultural fertility (figures 3.11, 3.12; Hyder 1997, 32; Robins 1997, 79–80, 88; 2002, 389). Rock art panels, placed near rich agricultural fields, particularly those associated with the onset of irrigation, subirrigation, or wet farming, were potentially constructed to provide a setting for surplus maize distribution through feasting and to attract labor for expanding Basketmaker



FIGURE 3.11. Solstice Snake petroglyph from Utah (photograph by Randy Langstraat, © 2011, all rights reserved).

economies in approximately 700 B.C.–A.D. 200 (Dowd and Zietz 2004, 14). In much the same way, Maya ceremonies took place, giving rulers the responsibility not only for agricultural fertility but also for resetting, replanting, or maintaining the seasonal and cosmic clocks. Both competitive feasting models would have operated in a prestige technology in which alliances, mates, and labor were part of an economy controlled by powerful individuals (Hayden 1998, 11–13, 26).

CONCLUSIONS

The performative aspect of Maya architecture, embodied in the use of light and shadow during theatrical religious ritual, shows power and connection with the natural world. At Calakmul's Structure IVc and at Palenque's Temple of the Sun, entrances were rebuilt to more precisely permit full sun to fall on a person standing in the temple entrance on the evening of the sunset summer solstice so as to frame the sunlight on an anticipated day (Dowd et al. 1995, 4; Mendez et al. 2005, 53–54). Maya monumental architecture was the setting for leader aggrandizing and community aggregation rituals that showed off complex record keeping and calendar prestige technologies.

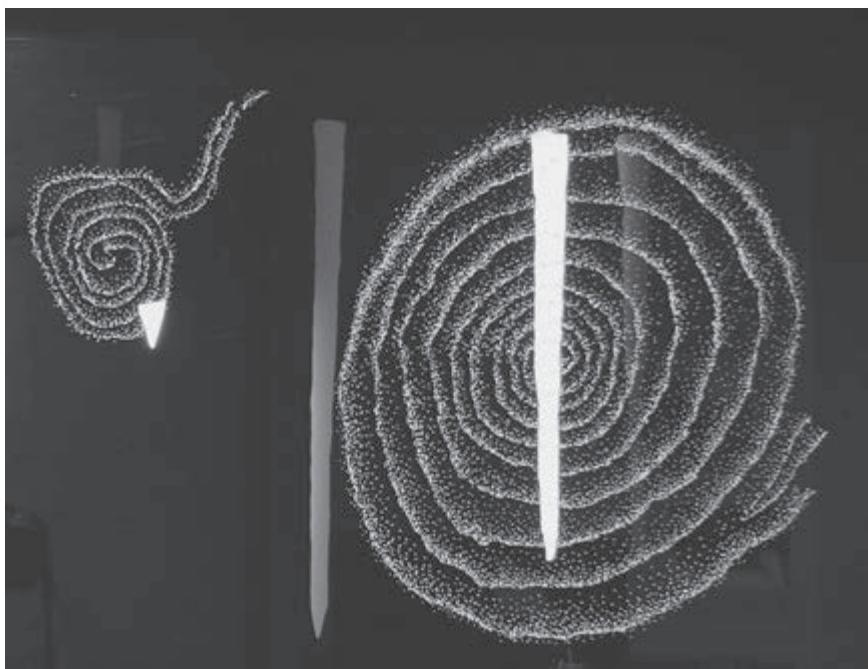


FIGURE 3.12. “Sun Dagger,” Fajada Butte, New Mexico (Sofaer et al. 1979, 290; reprinted with permission from AAAS).

Based on archaeoastronomical information encapsulated in architectural construction phases within Group E-type complexes in the Maya region, 20-day uinal intervals correlate with later alignment patterns that postdate influence from Teotihuacán (Aveni et al. 2003). Like the Central Mexican *veintena* or *trecena* festival calendars, seasonal religious rituals may have punctuated these uinal cycles celebrated within E Groups. The Maya region has considerable archaeological information with which to study the loci of festival performances or ritual circuits, while comparisons with Central Mexico’s ethnohistoric record and written or pictorial manuscripts may provide analogies useful for understanding variability in festival timing, ritual content, and enactment symbolism. Such ceremonies required transformation of the ritual landscape into temple and plaza cosmograms suitable for dramatic religious performances, giving people hope for influence over the earth’s caprices by communicating with their gods.

This work considers the landscape context of ritual and the built environment or geomancy, the use or synergy of natural and man-made topographic

features, like natural caves, cenotes, chultuns, or built temples. City plans functioned as Maya universe or world maps in microcosm (Ashmore and Sabloff 2002, 202–3, 210; Šprajc 2004, 162; Tate 1992, 111). As such, cities or buildings formed tropes, where a part substitutes for the whole, a pivotal concept in interactivist or constructivist theory (Dowd 1998; Turner 1991).

Hierophanies were public, private, or both. These were visual cues for ceremonies both large and small: a grand public display that created a sense of unity and awe for the audience in some cases, in others a private performer's mark on the floor or wall of a temple interior. Rituals would have been especially impressive as the ruler and/or religious leader appeared in a temple doorway brightly lit by the sun's rays. As Ivan Šprajc (2005, 212) has pointed out: "If these phenomena, which in certain architectural configurations produced light and shadow effects that may have been conceived as solar hierophanies, were observed on predicted dates, they sanctioned the ideology of the ruling class, reinforced social cohesion, and thereby contributed to the preservation of the existing political order."

Calakmul and Palenque have at least two examples of hierophanies in excavated and reconstructed architecture that show evidence of renovation with the intent to improve the light and shadow effects. Archaeologists can look for other minor changes in architecture that signal attempts to refine architectural hierophany designs. The history of architectural renovation for the purpose of creating hierophantic effects may show shifts in superstructure orientation or doorway alignment by comparison to a pyramid's axis or building plan.

At Calakmul, El Mirador, Uaxactún, and Wakna (or Güiro), interbuilding alignments emphasized winter solstice sunrise. At Palenque, winter solstice sunset lit an important sculpture panel to highlight God L, and an inter-building alignment also corresponds with winter solstice sunset. At Tulum, Structure 5's hierophany highlights the Diving God sculpture on the winter solstice. Mayapán's Castillo balustrade is lit in much the same way as Chichén Itzá's but on the winter solstice instead of the equinox. These are among the many alignments indicating that solar orientations at the winter solstice played an important role in dramatizing the turning point of the year, when the sun changed course as a prelude to seasonal change.

Future work may identify new hierophanies in Group E-type complexes, radial structures, and other types of structures correlated with rituals timed to uinal periods within the 365-day haab Mesoamerican calendar year intermeshed with 13×20 -day groups in the 260-day tzolkin, or sacred calendar. Astronomy anchored the unpredictable dynamics of agriculture to more predictable natural or cultural cycles. Calendar priests used horizon-based

astronomy in unique ways at each site. The ruler's political role in seasonal agricultural planting and harvest, as well as calendar events marking beginnings and endings, was commemorated architecturally in Maya ritual landscapes. The Maya established axes of power in cultural contexts uniting space, time, and place, creatively expressing cosmovision in profound religious terms.

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NOTES

1. The Gregorian dates of equinoxes and solstices vary by one day, according to the position in the year of our calendar system's intercalation (Šprajc 1990, 91).

2. In the American Southwest, winter solstice kiva dramas (*Soyáluña*) are shown in rock art where warriors confront horned serpents (Fewkes 1897, 268–73; 1898, 5, 25; Schaafsma 2001, 144). Jesse W. Fewkes (1898, 5) recorded a Walpi winter solstice ceremony (on the day of the sun setting in line with a notch in the horizon line) with secret observances at midnight. The conflict between warriors and the plumed Sun Serpent (*Pálülükönúh*) was meant to wrest the Sun back from a disappearance (by confronting destructive forces) (Fewkes 1897, 268).

According to Louise Burkhart (personal communication, 2012), Fray Diego Duran's (1971, 461–62) *Book of the Gods and Rites* reports that no one was allowed to sleep at night during the month of Atemoztli: "A most rigorous rule commanded that no one was to sleep on this night. Everyone was to remain watching in the temple courtyard, awaiting the 'coming of the water.' This vigil was called the *ixtozoztli*, which means 'to be on watch, or alert.' Thus all the men and women waited in their vigil in the temple courtyard, with bonfires against the cold. All of this was similar to the way in which people spend Christmas Eve today; people from the villages come to stay in the courtyard from evening on to observe this custom." In Fray Bernardino de Sahagún's (1974, 59; 2002, II:274–80) *Primeros Memoriales* and in book 2 of the *Florentine Codex*, there are detailed descriptions of when things were done. For example, in the New Fire Ceremony, the sacrifice and the drilling of the new fire took place at midnight.

Regarding the importance of the winter solstice in other parts of the world, see Aveni's (2009) discussion of the Roman calendar and the *Dies Sol Invictus*, which became the Christian Christmas. He argues that this is the most stressful time of year in any Northern Hemisphere culture and that it necessitates ritual conduct to return the sun to our hemisphere.

3. Mayanists' technical terms for the long count periods are day (1 day), uinal (20 days), tun/haab/year (360 days), katun (7,200 days), baktun (144,000 days), and pictun (2,880,000 days); actual Mayan words are *kin* (day), *wina:l* and *winik/winak* (uinal), *tuun* or *haab'/ha'b'* (tun/haab/year), *winik=haab'/ha'b'*, or *maay*, or *k'a(l)=tuun* (katun), and *piih* (baktun), here an equal sign indicates a compound word (John Justeson, personal communication, 2014).

4. A cosmogram is a diagram of the cosmos, or as Julia Hendon and Rosemary Joyce phrased it, "A representation of the entire universe through symbolic shorthand or artistic metaphor" (Hendon and Joyce 2004, 326). Cosmovision, as defined by Johanna Broda (1982, 81), is a cultural group's view of the world as expressed through symbols.

5. An example is found at Cival, where a four-sided, stepped depression in front of a central eastern structure in the plaza of an E Group is like an umbilicus centering the community from which metaphorical corn plants may sprout, if the jade celts found in the cache offering may be interpreted as corn (Bauer 2006, 29; Estrada-Belli 2011). Settlement centers were linked to the four directions, up, down, and the earth's surface by four-sided stepped platforms or plaza depressions. The image of a turtle's shell and an analogy with the earth's stone surface has been suggested by clefts, cracks, or holes in its "shell" (David Freidel, personal communication, 2012). The earliest carved, rather than additive, E Group bedrock features, such as stepped temples, platforms, and quadripartite clefts sculpted out of bedrock, would seem to reinforce the idea of the earth's surface being compared to a hard carapace and a place to anchor, plant, or "seat/enthrone" the maize plant, god, ruler, or city. See, for example, the earliest carved Middle Preclassic (1000–400 B.C.) bedrock features underlying Chan's E Group (Robin et al. 2012, fig. 6.3) and some early E Groups at other centers.

6. Linda Schele (1979, 49–50) reported: "The architectural hierophanies specify the critical instant in the tropical year as the winter solstice. Two events of powerful significance occur at the setting of the winter solstice sun. From the top floor of the Tower, and indeed from most locations in the Palace, the sun at about three in the afternoon of winter solstice is seen to enter the earth (the ridge behind the inscriptions) over of the approximate center of the TI [Temple of the Inscriptions]." Since the Tower was not in place until the eighth century, House E of the Palace might have been a better vantage point during the seventh century (Mendez et al. 2005, 47).

7. Tate (1986, 184–85) notes: "On summer solstice 1985, James Strickland and Tabor Stone . . . found that as the sun rose (at 5:43 AM at 63° east of North in a notch next to the highest hill on the horizon approximately 1200 m distant from the temple), it passed though the doorways of Structure 33. Inside the temple, the sun struck the only carved-in-the-round stone statue at the site, a twice life-size portrait of Bird Jaguar 4 seated cross-legged in a niche created by transverse buttresses in the rear wall

of the structure. The sun illuminated the statue of Bird Jaguar for approximately 7 minutes. This happened at least two days before and two days after the actual solstice, because the sun travels slowly relative to the horizon and the solstices.”

8. According to Tate (1986, 184), “On June 21, 1985 John Odom observed that the sun rose at 63° at 5:43 AM. Faint light shone in the central door of Structure 41, down the long narrow entranceway. At 6:00 AM the sun appeared next to the projecting flat stone that makes the stepped element in the right side of the doorway as one looks out. The sun illuminates a small portion of the rear wall, and the stepped shape of the doorway is visible. It makes a half-quatrefoil shaped patch of light on the floor and the rear wall.”

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Mountain of Sustenance

*Site Organization at
Dainzú-Macuilxóchitl and
Mesoamerican Concepts
of Space and Time*

RONALD K. FAULSEIT

The Codex Vienna relates a specific region within the Mixteca Alta of Oaxaca, Mexico, to Prehispanic cosmogony (Boone 2000, 89–100). A cosmogony is a belief system associated with the creation and organization of the universe; “it explains how supernaturals and humans came into being and how the gods and primordial ancestors created and ordered the land” (Boone 2000, 96). For many Mesoamerican communities the universe begins in the center of their town (López Austin 1988; Vogt 1969), and a large portion of the Vienna is devoted to the establishment of the physical world surrounding the town of Apoala (Furst 1978, 251–253). As such, the document establishes and reinforces the religious impetus for building important ceremonial centers within the landscape and their associated rites. Like many cosmogony texts, it provides a blueprint for the ceremonial traditions that are designed to maintain this order.

Much of the Codex Vienna document pertains to the work of building Apoala’s sacred community, detailing the rituals associated with the founding of the landscape, both man-made and natural. These include a series of scenes where important ancestral characters carry offerings and perform ceremonial rites associated with the founding of temples, shrines, and geographic features surrounding Apoala, such as mountains and bodies of water. In many ways, the ceremonial scenes in the Codex Vienna resemble ritual activities carried out today in indigenous communities throughout

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Mesoamerica (Brady and Ashmore 1999; Barabas 2003; Broda 2000; Broda et al. 2001; LaFarge 1947; Lipp 1991; Parsons 1936; Villa Rojas et al. 1975; Vogt 1969). These modern ceremonies, coupled with the information stored in documents like the Codex Vienna, serve as aids to archaeologists who wish to reconstruct the sociopolitical implications of site organization, including the role that landscape and ritual played in reinforcing concepts of power and ideology (Koontz et al. 2001).

For example, Ashmore (1991) proposed that ceremonial centers at several Classic period (A.D. 200–900) lowland Maya sites were constructed as an “*axis mundi*,” meaning they represent physical manifestations of the concepts of earth, sky, and underworld, the layers of Mesoamerican cosmology. She demonstrated this concept through analysis of the nonresidential structures located in the civic-ceremonial core at Copán, which were arranged so that the monumental structures located in the north were generally associated with the sky, while those to the south were associated with the underworld. The ball courts at Copán were located in the center to serve as conduits between one plane and the other.

In this chapter I incorporate evidence from archaeological, ethnographic, and ethnohistoric research conducted in Mesoamerica, as well as iconographic analysis of Prehispanic painted manuscripts, to link concepts of space and time to site organization at Dainzú-Macuilxóchitl in the Tlacolula arm of the Oaxaca Valley (figure 4.1) from the Terminal Formative (200 B.C.–A.D. 100) through the Late/Terminal Classic (A.D. 600–900) periods. I hypothesize that the site was organized around a central axis, delimited by the rising and setting points of the sun during the winter and summer solstices, and that the spatial arrangement of earth and sky elements on either side of this axis reflects Mesoamerican concepts born out in representations of the Prehispanic agricultural cycle and festival calendar.

SITE ORGANIZATION AT DAINZÚ-MACUILXÓCHITL

Dainzú-Macuilxóchitl is a sprawling archaeological site, encompassing roughly 150 structural mounds spread out over an area of approximately 4 km² on the communal lands of San Mateo Macuilxóchitl and San Jeronimo Tlacoctahuaya in the southeastern section of the Oaxaca Valley. The site is best known for the Dainzú Archaeological Zone, which consists of several man-made terraces located at the base of a small mountain, Cerro Dainzú, in the southern part of the site (figure 4.2). Bernal and Oliveros (1988; Oliveros 1997) conducted excavations there in the 1960s and 1970s, uncovering several

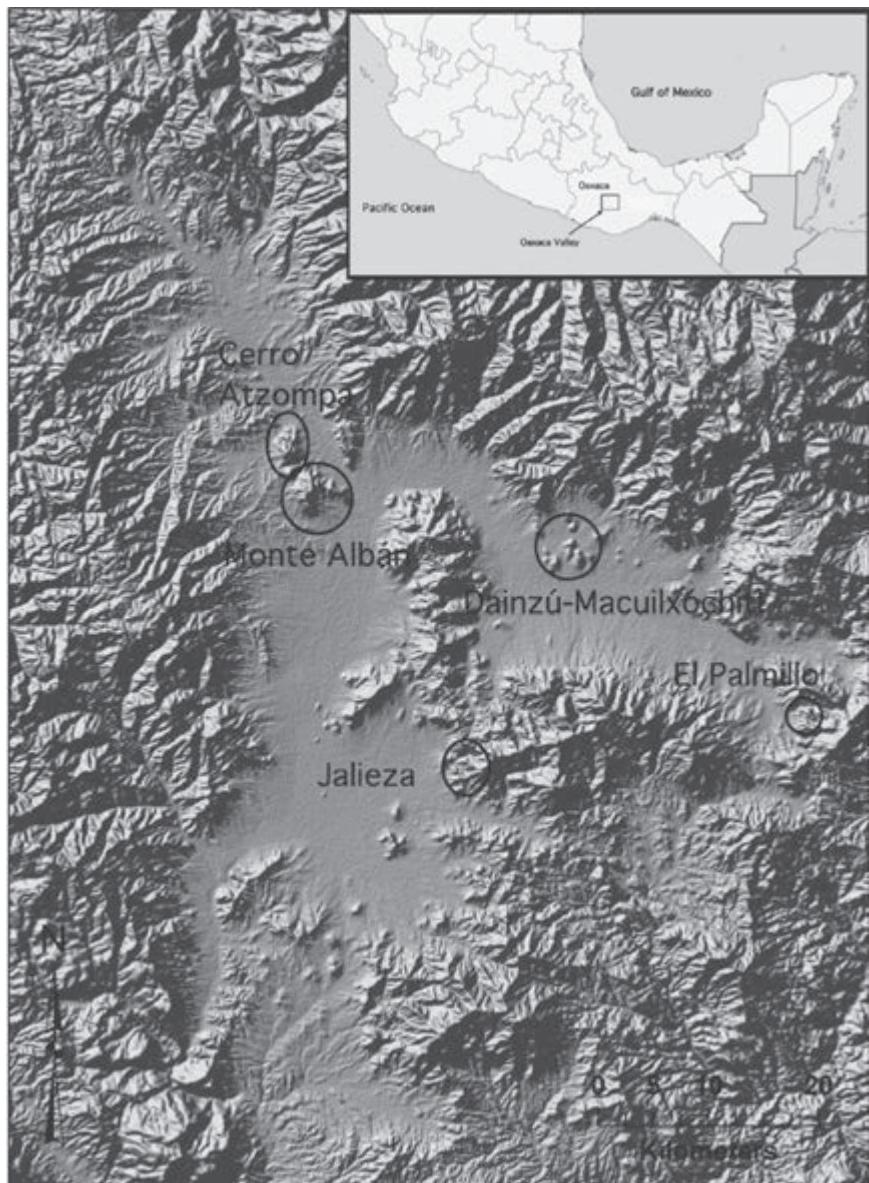


FIGURE 4.1. Valley of Oaxaca, Mexico (shaded relief source: SRTM NASA).



FIGURE 4.2. Landscape of Dainzú-Macuilxóchitl (background image source: Google Earth; reprinted with permission).

monumental public structures and elite residences, including the only Classic Period I-shaped ball court found within the greater site.

Some of the most notable finds from these excavations were the large facing stones carved in low relief that make up part of the outside wall of Building A, a monumental temple platform apparently constructed in the Terminal Formative. These images (figure 4.3) appear to depict individuals in protective gear, such as helmets, holding palm-size stone or rubber balls and taking part in what has been described as a ball game (Bernal 1968; Bernal and Seuffert 1979). Recently, however, several authors (Baudez 2011;



FIGURE 4.3. *Ball player/combatant from Structure A, Dainzú Archaeological Zone (after Faul seit 2013, 14, fig. 2.5).*

Berger 2011; Orr 1997, 2003; Taube and Zender 2009) have suggested that they represent individuals taking part in real ritual combat or ceremonial mock battles, and I believe that ethnographic studies support this interpretation (see below).

Within the Dainzú Archaeological Zone there are many iconographic references to felines or jaguars that date to Oaxaca's Early Classic period (A.D. 100–500) (Bernal and Oliveros 1988). For example, several of the carved stone slabs from Building A depict individuals that appear to be dressed in jaguar costumes (Bernal and Seuffert 1979). Perhaps the most significant jaguar reference is found on the façade of Tomb 7, located in an elite residence just below Building A, where the head and shoulders of a jaguar are carved in low relief along the tomb's lintel, and the legs and paws extend downward into the doorjambs on either side (figure 4.4). I suggest that the presence of the ball court, the jaguar iconography, and the depiction of a mock battle all support the idea that this ceremonial center was associated with the underworld, warfare, and perhaps sacrifice.



FIGURE 4.4. *Jaguar Façade from Tomb 7, Dainzú Archaeological Zone (after Faulseit 2013, 13, fig. 2.4).*

Approximately 1 km north of the Dainzú Archaeological Zone lies a small but prominent solitary mountain, Cerro Danush (figure 4.5), or “Old Mountain” in Zapotec. It is likely that Cerro Danush has always been an important feature of the landscape for the people who live in the region. In the late sixteenth



FIGURE 4.5. *Cerro Danush*, viewed from Dainzú Archaeological Zone (after Faulseit 2013, II, fig. 2.3).

century (ca. 1580 A.D.), the authors of the *Relación Geográfica* for the town of San Mateo Macuilxóchitl (shown on figure 4.2), located just east of the mountain, included a map of the area that depicts Cerro Danush in greatly exaggerated proportions directly in the center (Acuña 1984). Residents of the town today describe Cerro Danush as “*buun zhab*,” which literally translates as “devil” but can be loosely interpreted to mean that the mountain is possessed by a spirit. One member of the town even warned me that if I went to the mountain seeking treasure, I would get fooled and end up lost, as others have in the past. Myths of an ambivalent trickster spirit who resides inside a mountain and protects a treasure persist in highland Zoque (Villa Rojas et al. 1975), Mixe (Lipp 1991), Zapotec (Parsons 1936), and Maya (Bunzel 1952) communities, and the fact that Cerro Danush is considered to house such a spirit underscores its important role to the local people.

Markens and his colleagues (Markens 2011; Markens et al. 2008) have characterized Cerro Danush as the Mountain of Sustenance, similar to Mount Tlaloc, Cerro Gordo, or the great pyramid at Cholula, which were thought to be the sources of water, food, and wealth for their respective communities (McCafferty 2001). One of the sacred places established in the Codex Vienna is a mountain with a superimposed image of Dzahui, the Mixtec rain deity, who shares many characteristics with Tlaloc and Cociyo, his Aztec and Zapotec counterparts (Kowalewski 1970). This mountain is much larger than

the others depicted in the scene, and it takes the principal position, suggesting its importance as the source of rain and perhaps abundance within Prehispanic Mixtec mythology.

The *Leyenda de los Soles*, an early colonial document from Central Mexico (Bierhorst 1992), contains an account of the deity Quetzalcoatl retrieving corn kernels from an enormous granary located within Mount Tonacatepetl, the Mountain of Sustenance (Taube 1993). Afterward, the four Tlaloques, servants of Tlaloc, are summoned to snatch up all of the seeds and store them. Thereafter, the success of the corn crop, and agriculture in general, is forever tied to the provider of the rains, who resides in the mountains. This concept is also reflected in modern-day indigenous communities, such as the Mixe of Oaxaca (Lipp 1991, 48), who perform sacrificial rites on the New Year inside a cave on “Granary Mountain.”

Calling on extensive ethnographic research among Mixtec, Zapotec, Cuicatec, and various other ethnic groups inhabiting the state of Oaxaca, Barabas (2003) has defined an important relationship between these communities and the natural landscape, particularly with respect to local mountains, caves, and springs or waterholes. In fact, she proposes that the three are not easily separable and should be integrated into a single complex, “mountain-cave-spring,” which is strongly associated with agriculture and rainfall. In this complex, the mountain is seen as the link between the earth and the sky, where clouds form, lightning and thunder emanate, and rain is produced. As Villa Rojas et al. (1975) found, mountains are seen as the sources of abundance and fertility, where all natural and artificial commodities come from. Caves serve as doorways or entrances to the mountain’s center, where the deities live in their palaces and store their treasure. The spring, which is a source or origin of water, is thought of as emanating from inside the caves or the peaks of mountains.

Every May 3, residents of San Mateo Macuilxóchitl make a pilgrimage to the summit of Cerro Danush to perform ceremonies at a small shrine, where they take part in ritual dances and leave offerings for the Festival of the Cross (Markens et al. 2008). This ritual is undertaken to petition for a healthy rainy season and bountiful maize harvest (Orr 2001). Broda (1991, 2000, 2001) and her colleagues (Albores Zarate 2001; Broda et al. 2001; Vasquez 2001) have observed Festival of the Cross ceremonies at a variety of indigenous communities in the states of Guerrero and Mexico. She suggests that the modern rituals are the products of syncretism between the Catholic liturgical calendar and a Precolumbian festival calendar. The Festival of the Cross, in particular, resembles the Aztec festival of Huey Tozoztli as described by Fray Diego Durán

(1971), which took place on April 29 and was devoted to the Central Mexican rain god, Tlaloc. During this ceremony, the Aztec ruler Mocetuzohma, along with many high-ranking officials, climbed Mount Tlaloc to sacrifice a child as an offering made in front of an altar. In addition, offerings of food were made, and a carved stone image of the deity was adorned with flowers and clothing. Like the modern Festival of the Cross, the Aztec ceremony's intent was to petition Tlaloc for a healthy rainy season.

During a six-month archaeological field season in 2007–2008, I created a detailed topographic map of Cerro Danush using a Nikon DTM 420 total station and collected artifacts from the surfaces of 98 of the 130 man-made terraces on the mountain. At the summit, I found high-density clusters of fragments from Postclassic frying-pan-like censers at the base of a small pyramidal mound (Faulseit 2011, 2013). These censers, known as *sahumadores*, have been, and still are, used for burning incense during rituals, suggesting that the pilgrimage ceremonies to the summit of the mountain also took place during the late Prehispanic era, which supports Broda's (1991) claim that the modern ritual is syncretic.

In the Late Classic period, when the Monte Albán state dominated the Oaxaca Valley, the entire peak of Cerro Danush was transformed into a large pyramidal temple with walled-in patio and central altar (figure 4.6). Immediately below the temple complex, I mapped several terraces that appear to have contained the residences of high-status individuals. The surfaces of these terraces yielded high densities of ceramic fragments from large storage (*ollas barriles*) and preparation (*apaxtles*) vessels, suggesting they were the center of feasting ceremonies (Faulseit 2012).

Prior to my project, looters had unearthed a doorjamb from a tomb and left it on the surface of Terrace C5. The stone bore the image of the Zapotec rain deity, Cociyo, carved in low relief (figure 4.7), which is similar to the iconography depicted on Classic ceramic effigy urns recovered from elite tombs throughout the Oaxaca Valley (Boos 1966; Caso and Bernal 1952; Markens 2011). It depicts an individual dressed in the guise of Cociyo, with the image of a corn stalk and raindrop glyph. Sellen (2002) suggests that the images of Cociyo with corn stalks and raindrops depicted on the ceramic effigy urns represent elite priests or specialists assuming the role of the deity during rituals associated with the agricultural cycle of corn, a scene quite reminiscent of the ceremonies described by Durán (1971) for the festival of Huey Tozoztli.

The evidence presented above suggests that the landscape surrounding Dainzú-Macuilxóchitl, like Apoala, played a principal role in the site's founding and continued use. Although other small mountains are present in the area,

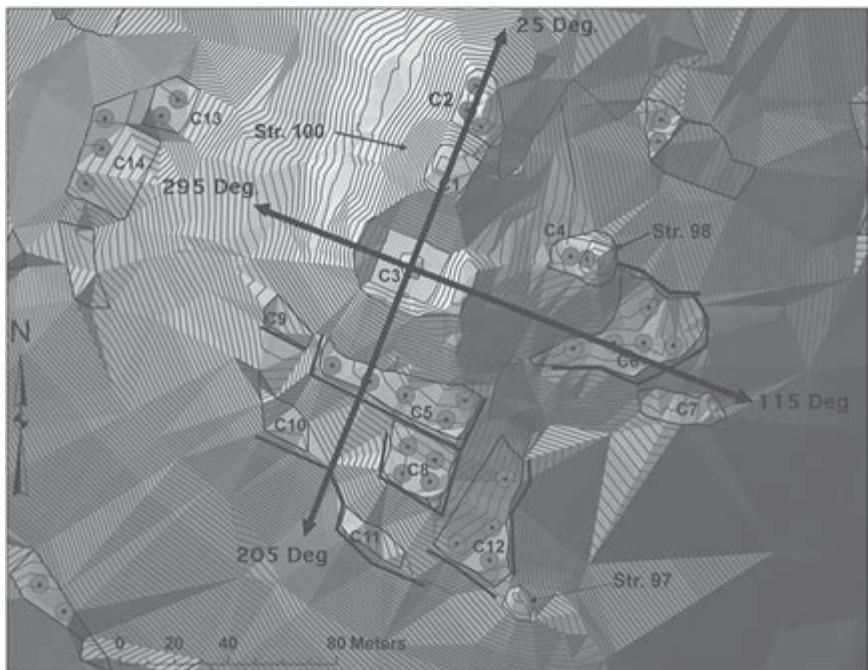


FIGURE 4.6. *TIN image of summit temple–palace complex on Cerro Danush with azimuths marked.*

which may have also played significant roles, it appears that the juxtaposition between Cerro Dainzú and Cerro Danush was particularly important. At the base of the former, we find iconography associated with warfare, jaguars, and the underworld, and at the summit of the latter, images of Cociyo, connecting it to sky, rain, and lightning. This division is similar to what Ashmore (1991) found within the ceremonial center at Copán, and I suggest that it carries sociopolitical, ritual, and ideological significance, connecting the passage of time with the surrounding landscape through the motions of the sun at the horizon.

SOLAR ALIGNMENTS AND THE RITUAL CALENDAR AT DAINZÚ-MACUILXÓCHITL

Kowalewski et al. (1989, 1:296) noted during their regional survey that, unlike other sites in the Oaxaca Valley, Late Classic structural mounds at Dainzú-Macuilxóchitl all seemed to share the same basic orientation, which they reported as 28° – 31° east of magnetic north.¹ The relationship is evident



FIGURE 4.7. *Image of Cociyo on carved stone from Cerro Danush (after Faul seit 2013, 182, fig. 8.2; illustration by Betty Cleeland; used with permission).*

in the Google Earth image (figure 4.2), as one can see the common orientation for several visible archaeological features near the southern base of Cerro Danush along the Pan-American Highway, which runs northwest to southeast through the center of the site. In this area Markens et al. (2008) excavated a large Late Classic monumental center they named the Lantiudee Complex, which most likely housed the ruling elites for the site at that time. Interestingly, they recovered the remains of a large ceramic jaguar statue in this complex (Markens et al. 2008).

During the Cerro Danush project in 2007–2008, I found that the basic alignment of the structural mounds that I mapped follow the same orientation that Kowalewski et al. (1989) reported (23° – 25° east of astronomical north), an axis that also appears to link the summit group of Cerro Danush to the terraces at the base of the Cerro Dainzú.² Even the main streets of the modern village of San Mateo Macuilxóchitl, which was established in the Prehispanic



FIGURE 4.8. Plan map of Terrace S19, with axis superimposed.

era, appear to maintain this orientation (figure 4.2). This alignment is also evident in the temple-palace complex at the summit (figure 4.6), which faces the Dainzú Archaeological Zone.

During the second field season in 2009–2010, I conducted comprehensive excavations on a man-made terrace located on the southern side of Cerro Danush, uncovering a commoner house complex (figure 4.8). All of the intact foundation walls I encountered were either oriented to between 23°–25° or its perpendicular axis, which yields an angle of 113°–115°. In the Valley of Oaxaca, this axis (113°–115°) forms an alignment from the eastern to the western horizon between the locations of sunrise on the winter solstice and sunset on the summer solstice (Peeler and Winter 2010, 10). For the house complex, this means that doorways facing east would greet the sunrise on the winter solstice, while those facing west would salute the sunset on the summer solstice. A similar solsticial alignment was reported for an arrow-shaped building at the site of Caballito Blanco, just a few kilometers east of Dainzú-Macuilxóchitl (Aveni 2001).

I propose that this southeast-to-northwest axis (113°–115°) separates the site of Dainzú-Macuilxóchitl into northern and southern planes, which effectively divide the landscape into areas associated with corn planting, preparation, and paying penance to the gods, and areas associated with rain, warfare, and the harvesting of maize. To illustrate this point, I relate the site's orientation to the “cosmogram” depicted on the first page of the Codex Fejérváry-Mayer (Aveni 2001). This Prehispanic document forms part of the Borgia Group of codices,

which are devoted to the Prehispanic calendar and the rites and ceremonies associated with it (Boone 2000). According to Aveni (2001), the diagram not only depicts important elements of the 260- and 365-day calendars but also places them within the physical constructs of space:

... the cosmogram, which appears like some sort of instructional or orientation preface on page 1 of that codex, concentrates on a number of other spatial properties. The five regions of the world along with their associated colors are enshrined in the four arms of the Maltese Cross and at the center: east (red) is at the top, west (blue) at the bottom, north (yellow) to the left, and south (green) to the right.... the four arms of the St. Andrew's Cross signify the four houses of the Sun in the sky, two in the east and two in the west. These are the inter-cardinal points that mark the extremes to which the Sun migrates along the horizon during the course of the year. (Aveni 2001, 150–51)

In this way, the diagram connects the sacred calendar to the physical landscape through the yearly motions of the sun along the horizon, providing an important connection between seasonal rituals and sky-earth elements.

Projecting the solsticial axis identified above at Dainzú-Macuilxóchitl onto the Fejérvary-Mayer cosmogram establishes a physical and seasonal division between the deities to the north and east on one hand, and those to the south and west on the other, providing a blueprint for ceremonies designed to maintain the physical order that was so carefully constructed by the ancestors and deities. On one side of the divide, we find Flint, Young Maize, Heart of the Mountain, and Tlaloc, who are associated with ceremonies that Durán (1971) observed taking place prior to or just after the onset of the rainy season. These specific festivals involve sacrifice, autosacrifice, and feasts conducted during ceremonies associated with field preparation and initial planting of corn. After June 21, the rains are falling in earnest, and ceremonies in the south and west appear to be associated with earth and water, as well as the harvesting of mature maize. Durán notes several ceremonies conducted during this period to honor the dead, which is represented on the cosmogram by Mictlantecuhtli, ruler of the underworld. Today, the Day of the Dead ceremonies take place in Oaxaca in late October or early November just prior to the corn harvest.

Juxtaposing the aerial image of the site (figure 4.2) with that of the codex (figure 4.9), one can see that the cosmogram is physically manifested within the layout of the site. The temple devoted to Cociyo is located at the summit of the mountain to the north, while the jaguar tomb and ball court are located at the base of the mountain to the south. The two face one another on opposite ends of the landscape, along an axis whose perpendicular line divides the space

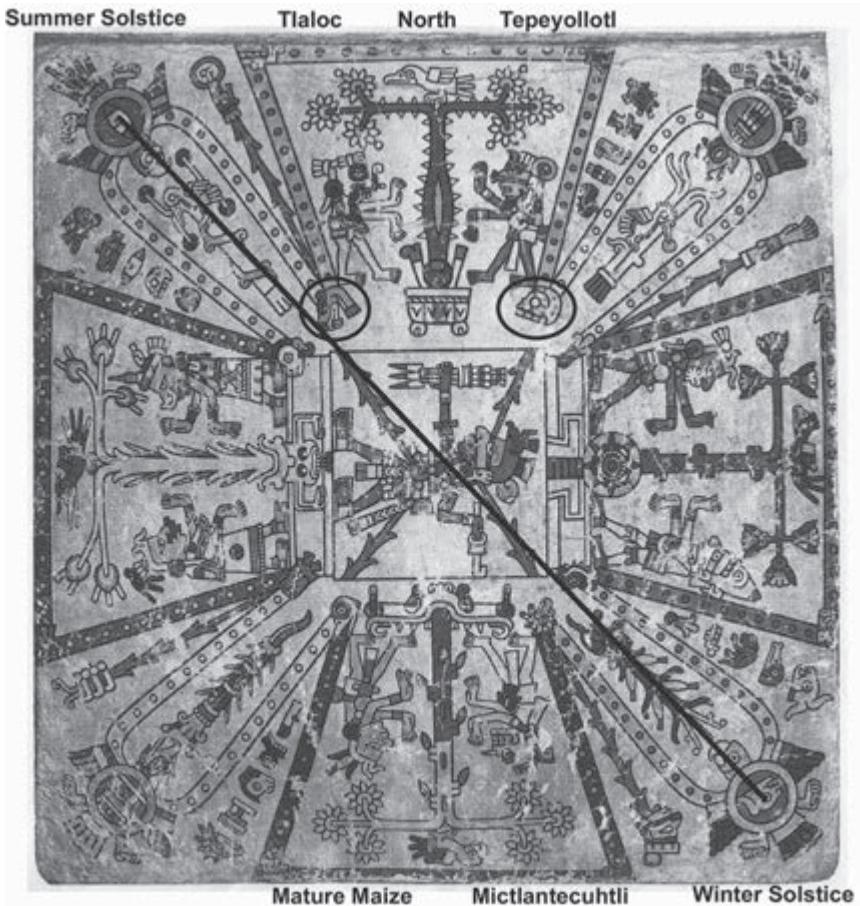


FIGURE 4.9. *Page 1, Codex Fejérvary-Mayer* (codex image courtesy of Akademische Druck-und Verlagsanstalt).

into dry and rainy seasons and their associated calendar festivals. The similarities between the image of Tlaloc in the north panel of the Fejérvary-Mayer cosmogram, Dzahui in the Codex Vienna, and Cociyo carved on the stone from Cerro Danush imply common ideas among highland Mexican communities concerning ritual landscapes, calendars, and site organization.

A closer look at the cosmogram reveals additional north-south references within the larger scheme, perhaps demonstrative of the activities incorporated within the individual ceremonies. For example, the north panel depicts

a ceiba or pochote world tree with sky elements on the left, Tlaloc with the serpent day signifier (circled, figure 4.9) below him, and earth-underworld elements on the right, with Tepeyollotl in his jaguar mask and death day signifier (circled, figure 4.9) below him. This appears to present another connection between the Prehispanic festival calendar and the landscape, which are also recorded in Broda's (1991) observations of the Festival of the Cross ceremonies. Along with the mountaintop pilgrimages mentioned above, she also describes the "Battle of the Jaguars" ceremony that occurs at the bottom of riverbeds or, in one case, at the town well, both considered conduits to the underworld. In the ceremony young boys dress up in jaguar costumes and take part in a mock battle, which is reminiscent of the ritual combat scenes depicted in the Dainzú Archaeological Zone.

The cosmogram and ethnographic data appear to provide a deeper understanding of the ritual significance behind the site organization and iconography at Dainzú-Macuilxóchitl. Like Apoala, the natural landscape surrounding the site appears to have been carefully considered during its establishment. To the north lies Cerro Danush, mountain of sustenance and conduit to the sky; to the south, Cerro Dainzú, center of warfare, death, and conduit to the underworld. Not only are these concepts established permanently in stone, but they are also reinforced yearly through the practice of calendar rituals. The axis between them is defined by the motions of the sun along the horizon, which separates the terrestrial space into wet and dry territory.

DISCUSSION AND IMPLICATIONS

The opposition of earth and sky is an important feature of the Mesoamerican world view that has been identified in archaeological contexts as early as the Early Formative period (1500–1000 B.C.), and ethnographic studies show it persists to the present day (Flannery and Marcus 1994; Joyce 2000, 2004; Lipp 1991; Marcus 1989; Monaghan 1995; Parsons 1936). In the Oaxaca Valley, archaeologists have identified divisions between earthly supernatural entities on the one hand, represented by "were-jaguar" iconography, and their sky counterparts on the other, represented by "sky-serpent" iconography (Flannery and Marcus 1994, 136–37; Marcus 1989, 170). Statistical analysis of the distributions of Oaxaca Early Formative (1900–850 B.C.) ceramics with these motifs at the site of San José Mogote found them to be "almost mutually exclusive" among distinct residential areas of the site (Flannery and Marcus 1994, 136; Pyne 1976), perhaps representing social divisions such as moieties between wards or *barrios*.

This pattern became more formalized in Oaxaca's Late Formative (500–200 B.C.) with the founding of the Monte Albán polity and subsequent development of state-sponsored religion. Joyce (2004, 198–200) suggests that, like the Classic Maya centers, the civic-ceremonial core at the great urban center of Monte Albán was intentionally constructed as an *axis mundi*, where “the southern end of the Main Plaza contained iconographic references to sacrifice, warfare, and the earth or underworld,” and “the North Platform included iconographic references to sky, rain, and lightning,” the same the basic pattern described here for Dainzú-Macuilxóchitl. Incorporating the ethnographic work of Monaghan (1990) in the Mixtec region of Oaxaca, where the Codex Vienna is believed to have originated (Boone 2000), Joyce (2000, 74) proposed that Mesoamerican communities maintain a “covenant” with the supernatural elements of earth and sky, invoked through practices such as sacrifice, auto-sacrifice, and material offerings that provide rains and the maize harvest. He suggests that Monte Albán's civic-ceremonial core was developed as a means for elites to perform public rites associated with this covenant that effectively bound the people taking part in these ceremonies to the rulers who organized them (Joyce 2000, 81).

Caso and Bernal (1952) characterized an increase in jaguar iconography at Monte Albán in the Terminal Formative. This trend is also apparent throughout the Oaxaca Valley and beyond, as the jaguar images found within the Dainzú Archaeological Zone date to this period (Marcus 1983a) and are postulated to represent an event depicting the subjugation of the site by Monte Albán (Orr 2001; Berger 2011). Spencer and Redmond (2000) also identified the appearance of jaguar iconography at that time in the Cuicatlán Cañada, which occurred with the expansion of the Monte Albán state into the region. They suggest that the jaguar was a symbol of the ruling class imposed by Monte Albán, and perhaps even the state itself.

These data suggest that long-standing and widespread supernatural phenomena became exclusively associated with elite households as the hierarchical order developed in Oaxaca. Marcus (1989) suggests that the supernatural entities of sky-lightning and earth-jaguar were incorporated into the ancestral lineages of the elite class and reinforced through communal ceremonies directed by the elites. Several rulers are depicted on carved stones at Monte Albán wearing jaguar outfits or with jaguar claws or other features, and the Cociyo urns are found exclusively within tombs of important elite families (Marcus 1983a, 1983b). The jaguar and Cociyo iconography found on the façades of the two elite tombs at Dainzú-Macuilxóchitl mentioned above clearly link the venerated ancestors buried within the elite residences with these supernatural entities.

I propose that Oaxaca's Late Classic (A.D. 500–600) transformation of Cerro Danush's peak into a formal temple-plaza complex represents the appropriation of ritually significant or sacred space by elites who assumed direct control of communication with the supernatural forces of sky and lightning, thereby taking responsibility themselves for the rain and subsequent maize harvest. Prior to that, in Oaxaca's Early Classic (A.D. 100–500), the ruling family at the site assumed the identity of the earthly powers related to the earth-jaguar-warfare complex and sacrifice. In this way, the sacred landscape, which was constructed by the supernatural ancestors of the elites, became an effective means for high-status individuals and families to continuously legitimize the hierarchical structure within the community. The calendar festivals provided a practical method to maintain this connection through yearly demonstrations that took place within the sacred spaces at the site.

Acknowledgments. In this chapter I have not only attempted to reconstruct the ritual meaning behind the solsticial alignment and site organization at Dainzú-Macuilxóchitl, but also to provide a deeper discussion of the sociopolitical implications for it. Of course this work did not take place in a vacuum, and I am grateful to the body of work conducted by the many outstanding archaeologists, art historians, and archaeoastronomers cited in the text. I would like to express my gratitude to the Foundation for the Advancement of Mesoamerican Studies Inc. (FAMSI) and the Middle American Research Institute (MARI) at Tulane University, which provided funding for this research. I would also like to thank both the Instituto Nacional de Antropología e Historia (INAH) and the people of San Mateo Macuilxóchitl for allowing me to conduct this work on their communal land. Lastly, I am grateful for the opportunity to present this work in honor of Anthony Aveni, whose guidance and mentorship has meant so much to me. I would like to thank Susan Milbrath and Anne Dowd for inviting me to take part in this volume, with a special nod to Anne for her editorial suggestions and advice.

NOTES

1. Topographic maps prepared for the area by INEGI show an easterly declination angle of approximately 6.5° in 1990. Therefore, the angles reported by Kowalewski et al. (1989) of 28° – 31° east of magnetic north would yield angles between 21.5° and 24.5° east of astronomical north.

2. The east-west boundaries of the Dainzú Archaeological Zone fall within a 20° to 30° azimuth span with respect to the peak of Cerro Danush.

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CLEMENCY COGGINS

"He who exercises government by means [of] his moral force may be compared to the Pole Star, which keeps its position while all the stars do homage to it." (Confucius in Wheatley 1971, 430)

The North Celestial Pole was a powerful cultural metaphor in southern Mesoamerica, identifiable from Middle Preclassic (1000–400 B.C.) times. Its endurance provides a valuable demonstration of the principle of disjunction (Kubler 1977). This applies to symbolic forms and images of great longevity; it posits that the meaning of forms change through the centuries if the form itself is constant; conversely, a long-lived image or concept, usually religious, will have a different *form* from the early one, if the original meaning has survived. In this study of the meaning and persistence of North Celestial Pole symbolism in ancient Mesoamerica, I will consider its meaning across two millennia and variations in its imagery and metaphors, remembering that the imagery of myth is "a cloak for abstract thought" (Frankfort and Frankfort 1946, 15).

THE NORTH CELESTIAL POLE

Mesoamericanist Zelia Nuttall's (1901) great work, *The Fundamental Principles of Old and New World Civilizations*, found that observation of the North Celestial Pole led to a number of fundamental cultural ideas; these included concepts of time and divinity that

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framed the thinking of early civilizations. Recently, however, archaeologist Lekson (1999, 82) observed that “[n]orth is a useless direction, it doesn’t help you plant.” This apparent contradiction also characterized the cultural role of north in ancient Mesoamerica where, from the Early Preclassic period (2000–1000 B.C.) and before, in its separation from subsistence-inspired religion, it became the domain of ruling elites. Later in the Postclassic period (A.D. 900–1519) it became the domain of an elite that specialized in the transport of luxury goods. In “The Study of Cultural Astronomy,” Ruggles and Saunders (1993, 4) conclude that although “observation is universal, perception and use are cultural.” For Mesoamerica, Nuttall (1901) was accurate in observations concerning the association of the North Celestial Pole with the relationship between gods and powerful rulers—whose role denotes a complex level of society, or fledgling civilization.

Such beliefs were also present in ancient Egypt, where pyramids were laid out in relation to the North Celestial Pole (Nuttall 1901, 383–86; Spence 2000), and tombs were located on the north side of a group so that royal dead would join the immortal circumpolar stars that never set (Frankfort 1948, 100). E. C. Krupp (1999, 11) explains that Egyptian priests carried a hooked wand “shaped like the Big Dipper . . . [which] stood for the stars that never died. When the priest touched the mummy’s mouth with this magical hook [it] gave the mummy’s spirit the breath of life.” Perhaps most like ancient Mesoamerica, the conceptual world of second millennium B.C. Shang China was rigidly oriented to the four directions, with the king’s authority derived from his location at the center (Keightley 2000, 81–85). The North Pole was seen as the unmoving hub of the universe, and the circumpolar zone as the “Forbidden Polar Palace,” while the emperor himself was identified with the celestial pole, the pivot of the world (Krupp 1989, 65). Mesoamericanist Beyer (1965, 285–90) associated the celestial pole with a monkey as seen in Mexican manuscripts, although his model for its relationship to the circumpolar stars differs from the one proposed here. Paul Wheatley (1971, 430–31) emphasized that Chinese astronomy was equatorial or “concentrating attention on the Pole and circumpolar stars . . . as opposed to the ecliptic-emphasizing nature of Greek and medieval European astronomy, and that based on azimuth and altitude as practiced by the Arabs.”

Mesoamerica is between 14° and 22° north latitude, just south of the Tropic of Cancer (23.5° north); here the circling circumpolar stars dip below the horizon during their daily and yearly rounds, whereas north of the Tropic of Cancer, as in Egypt, China, and to the north of Mesoamerica, these stars are always visible, circling the pivot of the night sky in a pattern that Nuttall (1901) believed inspired the widespread swastika sign. The principal

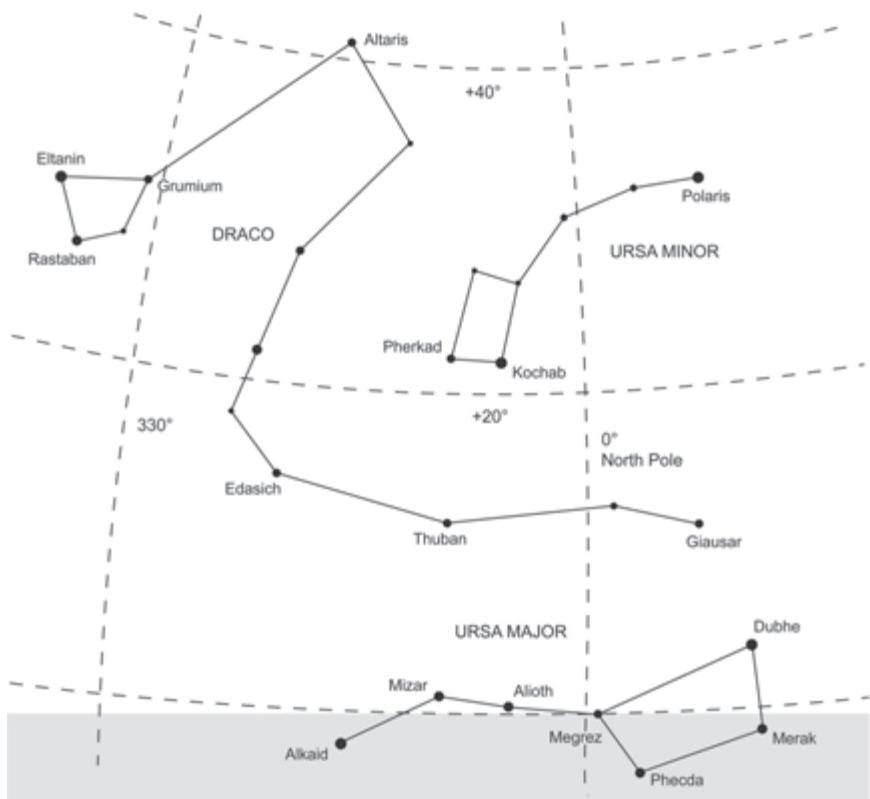


FIGURE 5.1. *Ursa Major and Ursa Minor flank Thuban, 8° west of the North Celestial Pole; Mizar, Thuban, and Pherkad in vertical polar alignment determined the orientation of La Venta, ca. 900 B.C. (drawing by Travis Parry after Vecchi (1994).*

circumpolar asterisms and those closest to the celestial pole are Draco and the Big and Little Dippers, also known as Ursa Major and Ursa Minor (Great and Small Bears) (figure 5.1). Most cultures have a name for Ursa Major, while the smaller Ursa Minor is often unnamed in surviving sources. I will use these names or Big Dipper and Little Dipper according to context.

MESOAMERICA

In Mesoamerica little is found in sixteenth-century sources concerning the Prehispanic perception of the North Celestial Pole and its constellations, although Ursa Major and Minor are mentioned, if inconsistently. Anthropologist

Köhler (1991, 260) notes that in the *Historia de los Mexicanos por sus pinturas*, Ursa Major is the Aztec deity Tezcatlipoca (Smoking Mirror) in feline *ocelotl* form—his nighttime star avatar. Like the jaguar, the smaller *ocelotl*'s spotted pelt was associated with the stars of the night sky and with the dark god, Tezcatlipoca, in the guise of the nocturnal jaguar, Tepeyollotl. While circling the celestial pole, presumably in his role as Ursa Major, one of Tezcatlipoca's feet lingered below the horizon as he rose and was bitten off by an earth or sea monster. A smoking mirror replaced this foot, and henceforth Smoking Mirror was his name and his most important attribute. The mirror was made of reflective black obsidian and “his image was painted with soot containing shining metallic flecks” (Caso [1958] 1967, 28). Tezcatlipoca’s role involved the four cardinal directions, and he symbolized the night sky. He was supreme god of the Aztecs, omnipresent and omniscient, the patron of royalty and as warrior of the north, identified with deified heroes (Caso [1958] 1967, 9, 27–31). These attributes of Ursa Major, the constellation of Tezcatlipoca, were probably associated two millennia earlier in Mesoamerica—most recognizable in obsidian mirror symbolism.

MAYA

In *Star Gods of the Maya*, Milbrath (1999, 38–39) notes that there are few ethnographically recorded Maya terms for the pole star but that the Big Dipper, with its seven stars, is called Vucub Caquix, or Seven Macaw, today in the Guatemalan highlands, while the seven-star Little Dipper is seen as the wife of Seven Macaw (D. Tedlock 1985, 360). The highland Quiche describe the two dippers as *paq'ab*, the spoons (B. Tedlock 1992, 181); this name emphasizes their common “dipper” shape and had a Preclassic (2000 B.C.–A.D. 200) analog at Izapa, south of the highlands, as discussed below.

In Maya lowland Yucatán, Mexico, star names recorded in sixteenth-century dictionaries list Xaman Ek for the North Star. Xaman Ek was god of long-distance travelers who relied on the North Star’s unvarying indication of north, and by inference the other three directions. When signifying north, Xaman Ek, as merchant-traveler, was portrayed as “God C,” a monkey figure in the Postclassic Maya codices, designated by the monkey profile glyph (T1016) (figure 5.2a–c).

GOD C

German scholar Paul Schellhas (1904) designated deities in Postclassic Maya manuscripts by letters of the alphabet. His third, “C,” was “The God



FIGURE 5.2. God C in Postclassic Maya codices and Classic Maya glyphs: (a) God C as merchant-traveler, Madrid 53c (Villacorta and Villacorta 1930, 330); (b) God C as the four directions, Madrid Codex 10c (Villacorta and Villacorta 1930, 246); (c) God C as Tzol16 and Tzol17 (drawing by Travis Parno after Thompson 1962, 457); (d) God C with prefix signifying “holy” (drawing by Travis Parno after Thompson 1960, fig. 43:8); (e) God C as Tz65 signifying the night sky (drawing by Travis Parno after Thompson 1962, 187).

with the Ornamented Face,” and he suggested this personified a heavenly body and was “probably the pole star” (Schellhas 1905, 19–21), although this glyph frequently represented all four cardinal points and so might be a sky ruler, as determined by his position at the center, and thus the entire constellation of the Little Bear. Eduard Seler (1996, 173) scorned scholar Förstemann’s (1902, 1903) idea that the Maya glyph for north in the Madrid Codex depicted

a monkey. Karl Taube (1992, 27) and Milbrath (1999, 274) have also rejected the identification of God C as the North Star.

A complex representation of north and the four directions, found on page 10 of the Madrid Codex, explains why God C has been identified with north and all four directions.¹ Each direction has an associated God C glyph with its color and with a picture of God C seated below it (figure 5.2b). This counterclockwise sequence, beginning in the east, names and personifies every direction as God C, although it is only his glyph that is the proper name of north with the *sak* or “white” prefix. This sequence, east, north (up), west, south (down), is the counterclockwise circuit of the Dippers.

In recent years many scholars have been interested in reading the God C glyph (T₁₀₁₆). William Ringle (1988) considered the significance (figure 5.2c) and reading of the God C glyph rather than its directional significance. Following the clue in Landa’s (in Tozzer 1941) alphabet, Ringle (1988) read T₁₀₁₆ as *k’u* (Yucatecan) or *ch’u* (Cholan), meaning “god,” thus signifying godliness in general rather than representing any specific god, and when preceded by the common “water group” prefix (T_{32–40}), it was read *k’ul*, *ch’ul*, indicating sacred or divine. Ringle (1988, 7) describes the glyph as representing a spider monkey. Most recent work has not addressed the monkey question, but Coggins (1988a, 134–40) discussed the Classic period (A.D. 200–900) portrayal of God C’s head, a monkey, on the ruler’s loincloth and concluded that it symbolized royal lineage and sexual potency. With the water group prefixes Carlson (1989) interpreted the liquid (which also describes the “scattering ritual” depicted on monuments) as signifying “divine essence,” whereas Stuart (1988) interprets the fluid as blood, and Coggins (1988a, 134–40) as semen. All three conceptually equivalent interpretations associate the God C monkey with dynastic ritual and royal communication with the divine.

No one has wondered why God C was a monkey, or why God C was associated with the north. In fact, the North Celestial Pole was a fundamental religious concept at the large regional centers of southern Preclassic Mesoamerica, where it came to personify the divinity and immortality of the nascent state, as personified by its ruler, and the pole’s earliest known associations were with a monkey. For the Classic Maya the North Celestial Pole embodied the following symbols, imagery, and concepts—many of them implicit in their earliest Preclassic origins: the night, a monkey, mirrors, world tree(s), and a large bird; in fact, the God C monkey glyph was the animate form of the mirror glyph, as seen on the “Foliated Cross” panel at Palenque (figure 5.3a; Stuart 2010, 291). This cluster of concepts had little, if anything, to do with the Sun, the Moon, Venus, other planets, the Pleiades, or the Milky Way. Unlike these, the North

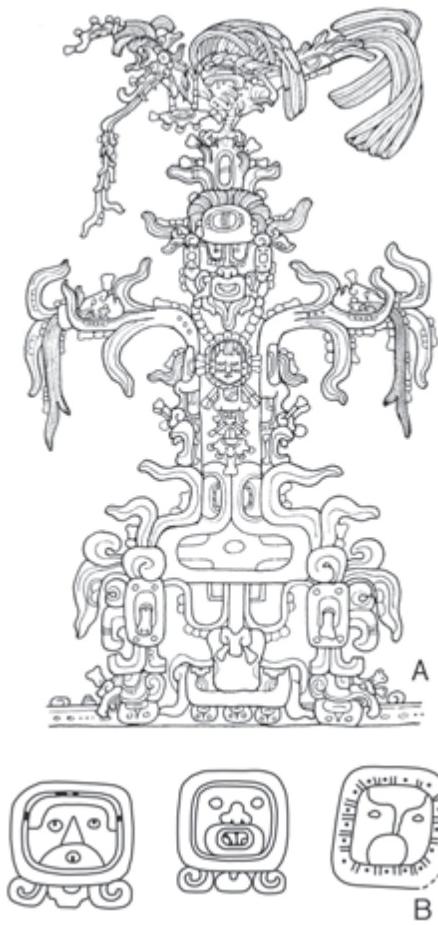


FIGURE 5.3. *Foliated Cross relief panel and Ahaw glyphs: (a) Foliated Cross, Temple of the Foliated Cross, Palenque (Schele 2000, 510; reprinted with permission); (b) Ahaw glyphs (drawing by Travis Parro after Thompson 1960, fig. 10).*

Celestial Pole and its constellations were entirely predictable, thus unchanging or eternal like the founding ancestors and creation.

NORTH AND UP

Celestial north and the circumpolar asterisms served as a star clock that marked both the nocturnal hours and the seasons—the latter by noting the position of a particular circumpolar star at the same time every night. The Big Dipper changes 90° on the great circle every three months. For a migrating population moving from the far north toward Mesoamerica, the North Celestial Pole would have been more important for its directional, timekeeping,

and season-marking roles than was the sun, which, if its stations were to be observed reliably against the surrounding landscape, required a settled community and localized annual calendar. Once settled, one of the earliest and most consistent Mesoamerican traits was the quadripartition of the settlement and its world. Such a division was primarily directional and spatial but also involved periods of time, or seasons of the year and their calendar in emulation of the radial, swastika-like movement of the pole and its constellations. Mesoamerican ritual circuits and dance followed an analogous counterclockwise rotation in imitation of these stars, around four-sided platforms, in four-sided plazas. Up and down were the tip and the base of the central world pole or axis, cross, or tree, so there were five directional points on the flat surface of the earth. This symbolism was exemplified by the five-point quincunx sign, which subsumed all possible directions and implied a completed circuit, or cycle.²

THE MOVING POLE

Many students of ancient astronomy, including Nuttall (1901; Brotherton 1982; Hatch 1971; de Santillana and von Dechend 1977) a century ago, have postulated that the precession of the equinoxes was recognized millennia ago. This phenomenon involves a shift in the position of the circumpolar stars of about one-third degree every 25 years. Due to the Earth's wobble, the North Celestial Pole traces a complete circle, 23.5° from the "vertical" pole of the ecliptic, every 25,800 years. Since stars far beyond Earth apparently do not move, the Earth's "wobbling" North Celestial Pole points to different remote stars in this 25,800-year circle. Polaris was not the North Star for ancient Mesoamerican peoples; in fact, it was over 2° from true north only three centuries ago. In order to discover that the North Celestial Pole was not absolutely reliable, a settled people with permanent sky-viewing markers, like mountains or monumental human constructions, would have to observe the circumpolar stars relative to the north horizon for more than a century. After 75 years it was evident to ancient astronomers that the rise point of the Big Dipper, for instance, had moved slightly relative to a mountain, and after 150 years they would have to propose a hypothetical rate of such movement for the circumpolar stars and thus extrapolate the full cycle.

THE NORTH STAR

Today Polaris is close to the North Celestial Pole, but from 3400 to 1400 B.C. it was the star Thuban (Alpha Draconis) in the tail of the serpentine

constellation. Around 2800 B.C., Thuban and its vicinity in the tail of Draco corresponded to the pivot of an almost symmetrical figure in which Draco served as the long axis. On either side, the two seven-star Dippers flanked Draco's tail. When Thuban was the pole star, it was the pivot around which these circumpolar stars revolved. By 900 B.C., when ritual activities were regularized at the elevated plateau of La Venta, Veracruz, however, Thuban, then about 8° west of the North Celestial Pole, continued to be revered as the pivotal star, and marked the north orientation for the site (figure 5.1). This was likely determined when Thuban in Draco, Pherkad in Ursa Minor above, and Mizar in Ursa Major below were vertically aligned to perpetuate the ancient mark of the North Celestial Pole as it was known from San Lorenzo more than a millennium earlier when Thuban was the pole. In reference to such a survival Wheatley (1971, 444) explains: "As the construction rituals associated with capital [sacred] cities were . . . frequently simulations of the cosmogony, it is natural that the archetypes on which they were patterned should have been drawn from the past. Indeed, the past was normative . . ."

SYMBOLS AND METAPHORS FOR NORTH

THE CENTER AND THE TREE

North as celestial center of the circling Dippers signified up, the top of an imagined pole or tree. This central axis corresponded to the pan-Mesoamerican world tree as the center of the four directions and their four trees. Mircea Eliade (1959, 36, 149–50) describes this *axis mundi* as a hierophany, a manifestation of the sacred, since it breaks through (and joins) the planes of heaven, earth, and the underworld: "Trees incarnate the archetype, paradigmatic image of vegetation." In ancient Mesoamerica, this axial tree evolved from such an agricultural symbol of generation to one of royal lineage, oscillating between diurnal solar-agricultural and nocturnal polar-lineage symbolism.³

The Classic period Maya Temple of the Foliated Cross at Palenque illustrates such a synthesis of subsistence, rulership, and theology. Here images of emergence and growth are expressed in the Foliated Cross (figure 5.3a). Often described as a tree, this cross is a maize plant, which has the mythical Principal Bird Deity perched at the top,⁴ while displaying the bearded God C monkey head emerging from the cleft plant, perhaps to invoke patrilineal continuity. This divine monkey is seen on the maize stalk in three masks, all with nocturnal brow mirrors and solar attributes. God C was the generative essence of the North Celestial Pole, its center, and five directions for the Classic Maya, as it was much earlier. In this role as progenitor, a monkey may replace the usual

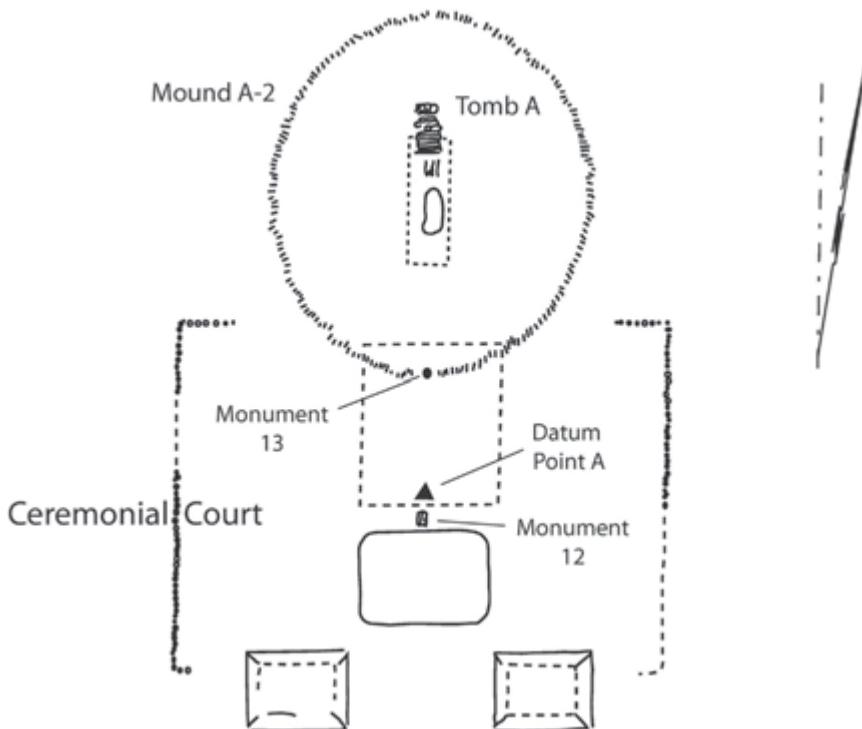


FIGURE 5.4. *La Venta, Tabasco, Complex A plan* (drawing by Travis Parno after Drucker et al. 1959, fig. 4; Drucker 1952, fig. 14).

k'in, or day sign, in Classic inscriptions. The monkey *k'in* glyph that represents one day is a spider monkey. The common Ahaw glyph is thought to depict a monkey face, with round eyes and round-framed mouth (figure 5.3b; Macri and Looper 2003, 65). The original model for the Ahaw glyph was the larger, louder black howler monkey. Thus Ahaw (Lord), the ruling day of the calendar round, was the nocturnal howler monkey, the model for God C, whereas the glyph for “day” was the diurnal spider or capuchin monkey. God C was a principle of divine origin rather than a sentient being of any kind.

LA VENTA, VERACRUZ, MEXICO

Located 15 km south of the Gulf of Mexico on a hill 20 m above the surrounding alluvial plain, the Olmec site of La Venta, Tabasco, may have been occupied as early as 1750 B.C. (figure 5.4). The principal period of occupation

was between 1200 and 400 B.C., with ceremonial construction in the second half of this period (González-Lauck 1994, 73). Middle Formative (1000–400 B.C.) La Venta was laid out with a long north-south axis oriented 8° west of true north (figure 5.4). Since there were no prominent landscape features on this alluvial plain, this directional focus was probably astronomical. By 1200 B.C. the pole had moved away from Thuban and the celestial pivot was unmarked by any star; however Thuban, now about 8° west of the pole, corresponded to this ancient north orientation, suggesting the archaizing, or extremely conservative retention, of Thuban as north, marked by the serpentine body of Draco.

A large pyramidal structure, C-1, marked this axis, close to the northern end of the site. Only Group A was farther north. This enclosed group, hidden from the south behind C-1, was out of sight with restricted access. The privileged northern Group A enshrined the axial tomb of at least one powerful ruler who was commemorated by rich, elaborately laid-out caches dedicated to his location at the northern extreme of the site's ceremonial center. In this position the dead individual would have been identified with the ancestor among the circumpolar stars above. Three of La Venta's colossal heads, probably still in their original positions, were located to the north of Group A where they face north in an east-west row. If north is the conceptual equivalent of up, these northernmost heads may have represented founders, former rulers, or ancestors, who had ascended to the circumpolar stars. A south-facing head, in front of Pyramid C, might have portrayed the current ruler or founder of the ruling lineage at the time Group A was constructed. Next to this head the massive Stela 2 represents an axial standing man in high relief that holds a hooked staff and wears a towering headdress. He is surrounded by what may be flying figures (figure 5.5).

GROUP A

Basalt columns flank Group A to create a Ceremonial Court (Drucker et al. 1959, 8). The dominant northern Mound A-2, a small version of the Great Pyramid at the southern end, was the locus of several phases of construction from the earliest phase, around 600 B.C. (González-Lauck 1996, 76). On the axis of A-2, beneath the later Monument 13, was a sequence of superimposed offerings of celts made of jade, serpentine, and other stones (Drucker et al. 1959, 133–46). These included a seated figure with a bird mask and a quincunx sign (figure 5.6a). At La Venta the bird-masked figure is an important element in the iconography of the center and of north, as are the quincunx designs, which diagram the actual plan of the Ceremonial Court, where lines drawn



FIGURE 5.5. *Stela 2, La Venta*
(drawing courtesy of John E. Clark).

from the four corners of the court cross at a center point (the excavator's "datum point A") and at the location of Monument 12, to be discussed below (see note 7). Such crossing diagonal bands signify the night sky.

Flanking the cache under Monument 13, two corresponding offerings (Nos. 9 and 11) were laid out in three parts: at the south, a deposit of red cinnabar; in the middle, an array of nine jade and serpentine celts; and at the north, a single polished concave iron ore mirror—magnetite in one cache, ilmenite in the other (Drucker et al. 1959, 176–82). Olmec figures that are depicted on monuments wear such mirrors, and a miniature one is worn by a seated jade figure in the principal Tomb A immediately to the north of these caches. Carlson (1981, 124–26) thought reflective stone mirrors were used for divination, and in the Classic period they were symbolic of rulership, as seen set into the forehead of the two Classic Maya deities associated with royal lineage, God K and God C (Schele and Miller 1983). Mirrors also signified the night sky of the north.⁵ In these diagrammatic caches, the mirrors correspond to the north and top of the arrangement of celts, while at the south, in the earth position, was cinnabar, the

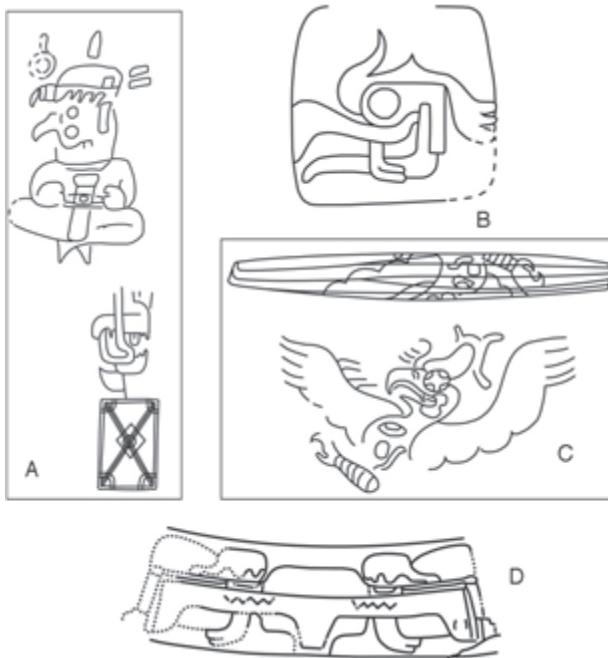


FIGURE 5.6. Mythical bird depicted on cached offerings in Group A, La Venta: (a) incised jade celts from Offering 2, Mound A-2 (Drucker et al. 1959, fig. 35); (b) jade earflare, Tomb A, Group A (Drucker 1952, fig. 59a); (c) obsidian core, Tomb B, Group A (Drucker 1952, fig. 48); (d) belt worn by monkey on Monument 12 (Drucker 1952, fig. 53b).

brilliant red mercuric sulfide placed in burials. After these offerings were made, Tomb A was constructed at the highest and northernmost point in Group A. Among the fine carved jades were parts of two square, perforated earflares, each incised with what Drucker calls a “bird monster” (figure 5.6b; Drucker 1952, 194, 195). This avian head has feather tufts, a raptor’s beak, and split fangs.

The clearest symbolic and ritual significance of Group A involves the south-north axis that culminates in the basalt column-enclosed tomb. Sprouting maize symbolism on two of the celts may evoke the rebirth of the dead ruler as an ancestor at the North Celestial Pole as well as an identification with the vertical maize cob itself, a prototype of the world tree. The celt with seated figure wearing a bird mask and the raptorial bird earflares display the avian element inherent in this celestial symbolism, while shining black iron ore mirrors evoke the night sky and the divine (figure 5.6a–b). Just south of the Ceremonial Court in Group A an exhausted obsidian core, once used to make prismatic blades, was found in the axial Tomb C. Obsidian mirrors were found in the contemporary Mound A-2 tomb, but this elongated, cylindrical, shining black obsidian core was incised with a harpy eagle that Drucker describes as “captured in the moment of striking its quarry” (figure 5.6c; Drucker 1952, 170). In



FIGURE 5.7. *Complex A, Monument 12, La Venta* (drawing by Benjamin Vining after Drucker 1952, plate 62; González-Lauck 1994, fig. 6.13).

its eye is a Kan Cross, the oldest Mesoamerican sign for the center and four directions. Critical elements in a long-lived complex, these interrelated symbols would continue to evoke the North Celestial Pole and its constellations for more than a millennium in the iconography of the ruler and his royal ancestor.

MONKEY MONUMENTS

A sculpture was found on the axis of the north Ceremonial Court just south of the crossing point of the diagonals between the four corners (figure 5.4; Drucker et al. 1959, 37). This was a carved columnar green serpentine figure, 1.22 m high but broken off at the base (figure 5.7). Designated Monument 12, it represents a monkey with arms and hands reaching up to the sky, with a long tail coiling upward on its back (de la Fuente 1973, 70–72). A wide band frames the monkey's high, bare, domed forehead, incised with two diagonal bands that continue down behind the large ears.⁶ The monkey has pronounced cheeks, a flattened nose, and a lobed raised frame as lips, a line of upper teeth,

and protruding tongue. Within sunken eye sockets, the round eyes have crossed bands; above these, a low relief “merlon” and feathered or split form that arcs to the sides atop incised lobed eyelids. The long ears, with raised rims, lie flat to the head with elongated lobes. A bib-like segmented collar on the chest has two bifurcated elements, and the monkey wears a wide belt that encircles the monument and that is incised with the upper jaw of a bird with elongated eyes, “flame eyebrows,” hooked beak, and split incisors (figure 5.6d). This monument represents an elongated monkey that reaches to the sky above the north-south axis and at the center point of the Ceremonial Court, thus representing both up and north as well as the center. Like the much later God C, this monkey’s eyes are round, its face and mouth have lobed, round borders, and like the God C masks on the Foliated Cross relief at Palenque, it has the diagonal forehead bands that signify the mirror, while the crossed bands (T561) in his eyes denote the night sky (figure 5.2e).⁷

A second cylindrical monkey sculpture, Monument 56, 1.24 m high, was found at La Venta, west of Group B. This animal’s head is thrown back, supported by its hands, to look upward at the sky. Like the one in Group A, this monkey has a frame around the face and long flat rimmed ears (de la Fuente 1973, 103–4). Monkeys on shafts were not limited to La Venta. At Tres Zapotes, Monuments F and G were such sculptures, although two to three times bigger and heavier (Stirling 1943, 22, 23). Monument F represents a monkey like the second La Venta one, with head looking upward and arms against the body and folded upward, with hands at the jaw line. The face of Tres Zapotes Monument F is simian, with a framing hairline, brows furrowed, and lips, nose, cheeks, and eye sockets rounded and protruding (de la Fuente 1973, fig. 231; Pool 2007, figs. 5.18, 5.19; Stirling 1943, plate 8a). The similar Monument G, also with head thrown back to look upward, is seriously damaged (Stirling 1943, plate 8b, c).

Christopher Pool (2010, 111) notes that seven such monuments, termed “tenoned busts,” were found at Tres Zapotes, and four elsewhere. It is reasonable to assume that these monuments were set into the ground upright and that the monkeys, or other individuals, with heads thrown back, were looking at the sky. The term “tenon” was used by Stirling (1943) since it was thought that the huge monuments were tenoned horizontally into major constructions at Tres Zapotes. But the monuments were not found in formal plaza groups with the monumental stone construction that would have been necessary to support such large heavy stones horizontally. There can be little doubt that they were set vertically. It is significant that a basalt column fenced precinct at the center of Tres Zapotes enclosed a vertical columnar serpentine monument

carved with the mat design later known to designate the royal seat or throne. Beneath this monument there were offerings that included spider and howler monkey bones, birds, and a jadeite celt (Pool 2010, 117).

HOWLER MONKEYS

The God C monkey persona and sign were originally inspired by the howler monkeys that inhabit the Mesoamerican rain forest, roaring their hoarse calls from the treetops at dawn and dusk (figure 5.8). Black, bearded adult male mantled howler monkeys (*Alouatta palliata*) measure about 1.15 m long, larger than the diurnal spider and capuchin monkeys that share their habitat (Carpenter 1934, 11). Howler monkeys, usually nocturnal, stay at the tops of trees, seldom descending. They belong to bands that comprise families of dominant males with unattached females and children.

Mating behavior begins with both partners displaying and exchanging “rhythmic tongue movements”; these involve the animal “opening its mouth, protruding its tongue and moving it rapidly in and out and up and down” (Carpenter 1934, 82). The faces of howler monkeys are surrounded with hair, males more heavily bearded, and they have prominent crossing canines, visible when they howl; these resemble the fangs often attributed to jaguars in Olmec imagery. The reproductive powers of howler monkeys are very evident in males, whose white testicles, pendant below the black furred body, are conspicuous. The Olmec were well attuned to the mating behavior of the howler monkey since it is shown on La Venta Monument 12, where the monkey’s projecting tongue, a signal for coitus, is an important feature (figure 5.7).

Most like human beings in appearance and behavior, the howler monkey signified the essence of male dynastic continuity, personified an immemorial past, and played a role in the *Popol Vuh* creation myths. Throughout the Classic period (A.D. 200–900), this was the role of God C. Howler monkeys, as represented in Tres Zapotes Monument F and La Venta Monument 12 in its pivotal location in Group A, symbolized the world tree and North Celestial Pole while personifying the immortal royal lineage. The mirror monkey, God C, an attribute of the Maya nobility, was integral to the larger construct that is the realm of the Principal Bird Deity, represented in Group A by the few surviving images of raptorial birds. This divine bird with serpent wings reigned over the highest heaven in the Classic period and, for the modern Maya of the Guatemalan highlands, eternally circles the pole as the Big Dipper (D. Tedlock 1991, 169, 170). The great bird also encircled the polar God C, as did the supernatural bird belt around the waist of the howler monkey that was La Venta Monument 12.



FIGURE 5.8. Mantled howler monkey (*Alouatta palliata*) (drawing by Benjamin Vining after <http://depositphotos.com/search/howler-monkey.html>).

OXTOTITLAN, GUERRERO, MEXICO

On the Pacific side of Mesoamerica, contemporary with Middle Formative (1000–400 B.C.) La Venta and Tres Zapotes, the theme of the celestial ruler-ancestor was restated in the Guerrero region far west of the Gulf. As described by Clark and Pye (2006, 245), “The first part of the Middle Formative saw a concerted effort of Olmec royal lines to . . . establish cadet lines in the frontiers, especially along the most critical trade routes.” During this Middle Formative period a noble Olmec family emigrated to Guerrero from the Gulf Coast and memorialized their royal ancestry in a monumental painting on a rock face at the entrance to Oxtotitlan Cave. The knowledge and ability to create this was probably exported from the Gulf in paintings on paper.

Thirty meters above the mouth of this cave the painted image of an enthroned ruler, almost life-size, is depicted frontally, facing north, to his right (figure 5.9). The ruler wears a bird costume that covers the face, head, arms, and back. The headdress and feathered cloak represent the harpy eagle. Peter Furst (1996, 75, 76) has described the harpy eagle as “the jaguar of the sky . . . the world’s most powerful winged predator.” A harpy eagle’s head is pale gray with a dark double crest, or “tufts,” which rise when the bird is alerted (figure 5.10), while the rest of the feathers are black and white. As howler monkeys may dominate the night from their trees, harpy eagles, about the same size, rule the daytime sky.



FIGURE 5.9. Painting of enthroned man above cave entrance, Oxtotitlan, Guerrero (redrawn from Grove 1970b, fig. 5).

The person's enveloping bird mask has two feather tufts, a pronounced raptorial beak, and a large round eye that Grove (1970b, 9) suggests was once inlaid with a "polished magnetite mirror." The headdress extends behind as a feather cape, and feathers hang from the extended arms. While primarily green, these feathers are also red and cream-tipped orange—the colors of macaw feathers, not those of the harpy eagle. The figure's legs correspond to the asymmetrical position of the arms—left up and right down.

The seat upon which this figure sits is the upper jaw of a mythological creature like the one at the top edge of a stone table throne at La Venta. At La Venta this upper jaw signifies the sky, while a figure is seated in the mouth of a cave immediately below. At Oxtotitlan a cave is also found below the painted throne, but there the cave is a real cave (Grove 1970b, 31). If one reads the Oxtotitlan table-throne as a cosmogram that represents the sky and earth, with dynastic continuity personified by the man wearing a harpy eagle headdress who emerges, or is born, from the earth or cave below (Grove 1973, 130), then a living ruler enthroned at La Venta may have been understood as the equivalent of the exalted ancestor seated on or in the sky above. The top edge of the La Venta table throne is usually described as representing the upper jaw of a jaguar or serpent signifying the sky. At Oxtotitlan, the edge of the



FIGURE 5.10. *Harpy eagle* (*Harpia harpyja*) (Howell and Webb 1995, plate 6.5; reprinted with permission).

throne may, however, have eagle traits since it resembles the bird belt worn by the monkey monument at La Venta (figure 5.6d), as Grove (1973) observed. Among the most striking traits of the Oxtotitlan figure are the winged arms. The right is extended downward before the figure, the left raised behind. I suggest that these winged arms correspond to the circumpolar constellations circling counterclockwise around the pole, as indicated by the position of his arms and legs and by the left-facing turn of his head.

This position, and the personal association of the ruler or ancestor with circling Dippers, probably came from the Gulf. Close to San Lorenzo, a life-size dismembered torso from Loma del Zapote was published by Cyphers (1999, fig. 5; Cyphers and di Castro 2009, 28). From the remaining stumps of the arms and legs it is apparent that this figure had assumed the same position as the Oxtotitlan figure, with one leg down, the other up, as di Castro noted, further suggesting that the stone figure once sat on a stone throne.

like the “altars” known from San Lorenzo and La Venta (Cyphers and di Castro 2009, 168–72).

At Oxtotitlan, levitating in the air just above the surface of the figure’s winged arms and hands are blue-green bars, dots, and triangular forms. Grove (1970a, 10) described these as “jade ornaments,” and Reilly (1996, 40) as “jade bracelets.” Surely they are numerical bars and dots that indicate some kind of count; they are clearly shown as conceptual by their unrealistic position in the air above the outstretched arms. If they are numerals along his arms, the bars and dots may correspond to time, since the Dippers serve as the “hands” of the nighttime sky clock. Transformed in apotheosis as the harpy eagle and surely an ancestor, this figure personifies the stars that measured time. His body was the celestial pole while the winged arms signify the circling constellations. He also corresponds, as axis, to the columnar howler monkey at La Venta, with its harpy eagle belt, brow mirror, and crossed bands attributes; that monkey was the pole itself, while the bird his costume. At Oxtotitlan the howler monkey (God C) role and significance had been transformed into the great raptor. Soon, in southern Mesoamerica, this harpy eagle of the northern sky was transformed again and became the Principal Bird Deity of the south—more macaw than eagle, patron of rulership and of the Maya long count. The relationship between the monkey and the great bird will be clarified in the discussion of monuments at Kaminaljuyú and Izapa.

KAMINALJUYÚ, GUATEMALA

Kaminaljuyú in the Guatemalan highlands is well known for its large corpus of Late Preclassic period (400 B.C.–A.D. 200) stone sculpture. In 1961 a matching pair of collared tetrapodal drum-shaped monuments (dubbed “altars”) were found (figure 5.11a–b). Dated by Parsons (1983, 146; 1986) to the last two centuries B.C. (200 B.C.–A.D. 1), during the Early Izapan Horizon (e.g., within the Terminal Formative or Late Preclassic Izapan sculptural style, specifically the Early Arenal or Early Miraflores substyle of 200 B.C.–A.D. 200), he notes that while the two sculptures have the same design, they are reversed. The principal figure on each column is the large-beaked bird identified as the Principal Bird Deity of Middle and Late Preclassic times. This mythological bird is also found at Izapa where Bardawil (1976, 196), who defined and named it, believes this supernatural construct was first formulated; however, the bird has subsequently been found represented in monumental stucco masks at earlier Preclassic sites in Petén, far to the north (Hansen 1992; Taube et al. 2010). In the early southern representations in stone at Kaminaljuyú and at Izapa,



FIGURE 5.11. Twin carved low-relief basalt cylinders, Kaminaljuyú, Guatemala: (a) ‘Altar’ 9 (Parsons 1986, fig. 140; reprinted with permission); (b) ‘Altar’ 10 (Parsons 1986, fig. 141; reprinted with permission).

the bird usually has its wings spread. On Kaminaljuyú Altar 9 the bird faces toward its left wing with a *k'in* (day, light) sign infix, while on Altar 10 the bird faces the right wing, also with an infix *k'in*. In each case the wing that is behind the head has an *akbal* (night, darkness) sign.

Whether facing right or left, each bird also has a darkness *akbal* emblem at the front of its headdress identifying it with the night. In the protruding abdomen of both birds there is a God C profile of the type later found in Classic Maya writing. If, as Parsons (1983, 154) believes, the internal God C sign connotes the essential Principal Bird Deity, it must also denote the North Celestial Pole and its constellations in their association with the ruler.⁸ The Principal Bird Deity has literally incorporated God C's celestial symbolism as the imagery of rulership changed over the centuries. The twin cylinders face in opposite directions and probably flanked a central element. If the two flying birds (both the Principal Bird Deity) symbolize the circumpolar constellations, the cylinder with the bird facing its left, Altar 9, may signify the rising Big Dipper, and the other the descending one in their continual counterclockwise cycling. There was probably another critical purpose for these monuments. The complementary drums may have been set at either side of a stela like Kaminaljuyú Stela 11, which portrays the Principal Bird Deity in the sky above the ruler, or they might have been used in funerary or accession ritual to flank a ruler living or deceased who was to be apotheosized as the ancestor at the North Celestial Pole.

IZAPA, CHIAPAS, MEXICO

At Izapa, Chiapas, 100 km west of Kaminaljuyú, these themes come together and are expressed in a narrative form that clothes the esoteric theology of the northern sky in an apparently more accessible mythology of creation. It is generally accepted that the Hero Twins of the *Popol Vuh* epic were represented on several stelae in Group A at Izapa (Norman 1976, 94; Lowe, Lee, and Martinez Espinosa 1982, 40, fig. 2.10). The *Popol Vuh*, an allegory that dealt with the divine creation and mythology of the visible world, was clearly basic to religion and ritual at Izapa. The primary dimension of Izapan religion was time, however, and the calendars, as Lowe, Lee, and Martinez Espinosa (1982, 269) observed when they described Izapa as “a ‘Greenwich’ and ‘Mt. Palomar’ for its time” to emphasize this primary role as narrator and regulator of time, by observation. Vincent Malmström (1973, 1997) postulated that the 260-day calendar was created at Izapa because the site’s location between 14.42° and 15° north latitude is where the solar year is naturally divided into 260- and 105-day segments by the two solar zeniths on May 8 and August 13. The Maya long count began on the second zenith, August 13, in the year 3114 B.C., thus associating the date for the beginning of time with this latitude and this place. The significance of these dates, however, was the same for all places along a band that extended from Izapa to Copán. If not the source of the long count, Izapa was a prime Late Preclassic religious center where ritual and performance celebrated the Creation, narratives of the *Popol Vuh*, the Sun, the seasons, and the night sky (Lowe, Lee, and Martinez Espinosa 1982, 275–89)—but not, as Lowe, Lee, and Martinez Espinosa (1982, 316, 317) have observed, ritual involving historic individuals; no important burial was found, and “Izapa carvings glorify concepts not people.”

The earliest ceremonial construction at Izapa in the Middle Formative (1000–400 B.C.) was in Group B (850–650 B.C.) (Lowe, Lee, and Martinez Espinosa 1982, 123). Like all of Preclassic central Izapa, Group B is oriented 21.5° east of north, with the principal axis pointing north to the volcano, Tacaná, 25 km beyond (Lowe, Lee, and Martinez Espinosa 1982, fig. 2.11) (figure 5.12). Like La Venta, Izapa is an elongated site with a north orientation (Clark 2001, 194). The two largest pyramidal structures at Izapa are at the north and south ends of the long central axial Group H with the largest plaza (Lowe, Lee, and Martinez Espinosa 1982, 259). Mound 25, at the north end, is a small replica of Tacaná, visible beyond, while the group’s southern Mound 60 is the highest at the site. Group A, on the southwest, is located farther south and west than Group B, so their relative positions on either side of the axial Group H are offset. They are alike, however, in having many carved monuments, while the



FIGURE 5.12. Site plan, Izapa, Chiapas with Groups A and B flanking H (Coggins 1996, fig. 10; courtesy of the New World Archaeological Foundation).

huge axial Group H apparently had none (Lowe, Lee, and Martinez Espinosa 1982, 263).

GROUP B

In the northeastern Group B, three columns with balls on top are set in front of the large northern Mound 30, where a table throne carved with crossed bands is axially set immediately to their south. As gnomons the columns would have confirmed, by observing shadows, the days of solar zenith; the long count is calculated to have begun from the second zenith. Several stelae in this eastern plaza celebrated themes of rebirth, emergence, and rising (Coggins 1982, 1996).⁹ Among these, facing east toward the winter solstice sunrise, Stela 11 portrays a bearded, winged solar figure rising from the gaping jaws of a large squatting toad earth monster (figure 5.13). On its shoulder is the poison gland of *Bufo marinus*, while the back half of its body consists of the profile head of God C. This immanent head signifies darkness, as does the nighttime crossed bands emblem at the center of the creature's body, which is at the base of the eastern path of the Sun God's rise from darkness into the sky.

GROUP A

In contrast to the eastern Group B with its themes of rising and emergence, Group A to the southwest has images of descent.¹⁰ Principal Bird Deity



FIGURE 5.13. Group B, Stela 11, Izapa
(drawing by Ayax Moreno [Moreno
2000]; courtesy of the New World
Archaeological Foundation).

imagery is found on four of the carved monuments of Group A, where this celestial bird has been interpreted as Seven Macaw, known from the *Popol Vuh*. Principal Bird Deity monuments are set on the axis of the principal north and south mounds of Group A. At each end of Group A the axial stela portrays the great bird's flapping descent from the sky. On Stela 2, at the southern Mound 58, a large humanoid form with bird headdress and serpent wings of the Principal Bird Deity flies straight down from the sky above a calabash tree with earth monster roots, and at each side a small male figure gestures toward the descending bird; these are understood to be the Hero Twins (figure 5.14). These serpent wings are marked with crossed bands, signifying the night sky, while the bird-man's descending body bears the backward-facing head of God C.

At the north end of Group A, on the axis of the northern Mound 56, Stela 6 is a three-dimensional representation of the same toad earth monster as Stela 11 in the eastern plaza, but here the toad is swallowing the setting crescent



FIGURE 5.14. Group A, Stela 2, Izapa (drawing by Ayax Moreno [Moreno 2000]; courtesy of the New World Archaeological Foundation).

moon (Lowe, Lee, and Martinez Espinosa 1982, fig. 15.5b). The monuments of Group A celebrate the earth and the descent or setting of heavenly bodies. The group was dedicated to the night sky and its ritual, to a deified ancestor, and to female imagery as exemplified by the toad and the moon, whereas Group B, in a worldwide gender dichotomy, involved the sun, solar ritual, and the masculine (Coggins 1988b). The two groups had different roles, different purposes, and probably their own religious specialists.

In front of the northern Mound 56, Stela 4 mirrors Stela 2 at the south with its own descending anthropomorphic bird (figure 5.15). Like the Stela 2 bird, this one has a God C body and crossed bands on its proper left (east) wing. This bird flies downward upon the head of an elaborately costumed human figure with feet firmly planted on the Izapan earth band. The bird is of the same scale as the figure, unlike the smaller “twins” on Stela 2. Garth Norman (1976, 98) observes that “there seems to be an especially close relationship between the descending deity and the human figure below him.” Facing to his



FIGURE 5.15. *Group A, Stela 4, Izapa*
(drawing by Ayax Moreno [Moreno
2000]; courtesy of the New World
Archaeological Foundation).

right, this man wears the Principal Bird Deity headdress and has wings on his forearms and a winged tail or back rack marked with crossed bands. The figure also wears a head centered on his belt at the top of the loincloth; described as a skull (Norman 1976, 99); this is the complete head of God C in its earliest known association with a royal loincloth, emblem of royal lineage. In his raised left hand he holds an implement with its tip perpendicular to the shaft while a hooked device is attached to his raised forearm. In the lowered right hand he holds another such object, but with a curved tip; this hook is attached to this forearm as well.

Izapa monuments generally depict what are apparently ancestral rulers, deities, and deity impersonators involved in ritual and mythical events. Stela 4 at Group A's north-central position most closely resembles the enthroned winged figure at Oxtotitlan Cave. Both face to their right; both have wings, back feathers, and bird headdress; both wear crossed bands to indicate their axial nocturnal celestial location, and they make the same gesture. The Izapan figure's arms assume the same position as the enthroned man at Oxtotitlan.¹¹

I suggest that the two are founders, most highly esteemed rulers, who have joined the ancestors at the celestial pole, as signified by the bird, which in both places is the Principal Bird Deity, if in different stages of abstraction and reference to night birds. In his northern position in the group, on Stela 4, this man is clearly associated with Tacaná, the volcano visible beyond to the north and from which the Big Dipper rises.

The Oxtotitlan Cave figure and Stela 4 at Izapa share the theme of circling constellations in which the ruler is the axis and the Dipper on the east (the person's left) rises while the Dipper on his right (west) descends as visible here behind the monument. The Big Dipper, when ascending, would have been seen as a rod with its tip pointing outward at a right angle, while the descending Little Dipper resembled a spoon facing inward, like the Big Dipper instrument used by Egyptian priests mentioned above, or the spoon that modeled the Big Dipper on Chinese celestial divination boards (Carlson 1975, 756). The man on Izapa Stela 4 may be seen as the axis holding two such stellar instruments, distinguished from each other, in his raised left hand and lowered right hand.¹²

At La Venta, in what may be a variant reenactment of the same scene displayed at Izapa, Stela 2 in front of the Great Pyramid, at the north end of the long public plaza, also portrays the ruler as axis—possibly the revered man in the Group A tomb (figure 5.6). Six smaller aerial counterclockwise figures circle him, three on each side, carrying a variety of hooked staffs. The figures on his proper left side face toward him as they fly upward, as does the top descending one on his right, while the lower two descending ones face away. Here the inward-facing Big Dipper may be rising, while the Little Dipper descends with the apotheosized ruler as the axis.

This principle and the shape of the counterclockwise circuit of the Dippers seem to have governed the plan of the site of Izapa (figure 5.16). The central Group H is the long axis, or the pole, of the site. Group B on the east, located farther north, or higher relative to the north, has monuments with themes that symbolize rising and emergence. On the west, Group A is located southwest of Group H, or lower (farther south) relative to Group B, and its monuments depict themes of descent and setting. Thus the plan of Preclassic Izapa might be said to emulate the counterclockwise movement of the Dippers around the North Celestial Pole, as enacted by the man on Stela 4. A processional circuit may have emulated this movement of the Dippers. Beginning in the eastern Group B, the tour would proceed north to the apex, west and south into Group A, and to the nadir, Mound 60, before turning east and north to terminate and begin again with the rising celestial bodies in Group B.

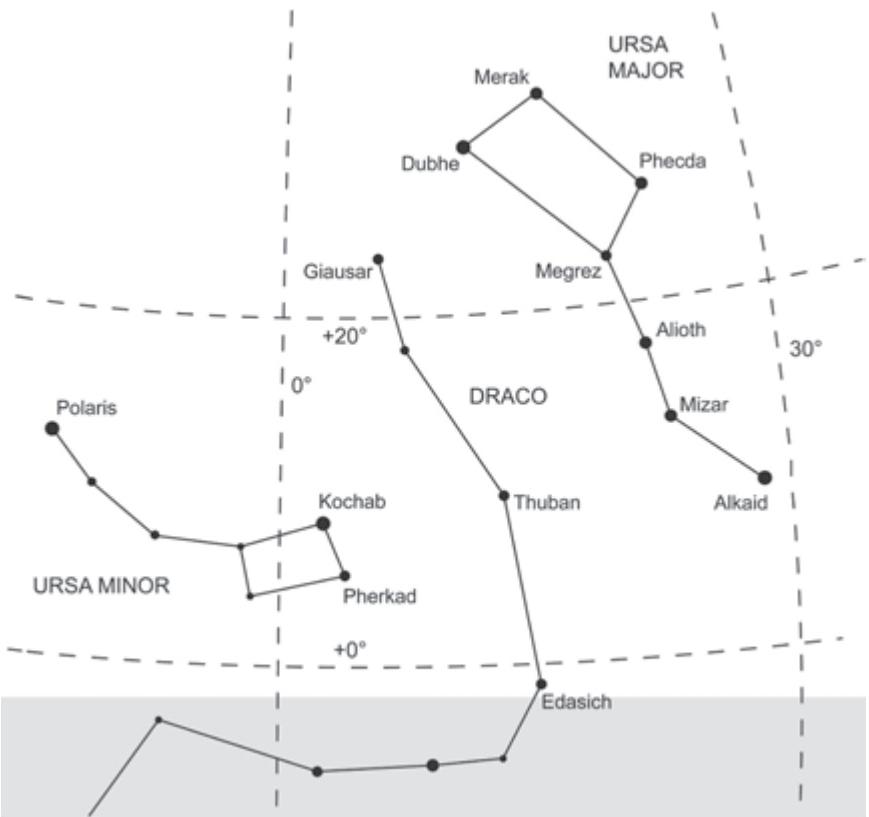


FIGURE 5.16. *Izapa, northern sky, winter solstice, 24:00, December 21, 300 B.C.* (drawing by Travis Parro after Vecchi 1994).

DISCUSSION

The Hero Twins are identified with the sun, moon, and planets; but tied to the ecliptic, separate from the celestial pole and its constellations. In the *Popol Vuh* story of the third creation, after the unresponsive wooden people were destroyed in a flood or became monkeys, the great bird, Seven Macaw, arrogantly presumed in the darkness to be the resplendent Sun and Moon (not yet officially created). “For my eyes are of silver, bright, resplendent as precious stones” he said (Recinos 1950, 93). In fact his eyes shone like metallic mirrors. Grandparents or ancient creator gods instructed the Hero Twins (who, in some accounts, would become the real Sun and Moon) to eliminate Seven

Macaw, who was the false Sun. They succeeded. This allegory of the defeat of the false nighttime Sun in the form of Seven Macaw by the true young Sun is analogous to the foundation myth of the Aztec. In the Aztec story Huitzilopochtli, newly born eagle warrior Sun, kills his sister, the Moon, and routs his innumerable brothers, the stars, in a reenactment of the daily battle between night and day.

In the *Popol Vuh* Seven Macaw and the two older brother monkeys of the penultimate creation are effectively neutralized by the Hero Twins of the final creation. These brothers, rightful heirs of their father and creator grandparents, were wise, accomplished scribes, craftsmen, and musicians, but they are described as despotic and jealous of their younger half brothers, who are more ordinary hunters and ball players. The twins decide to eliminate their older siblings; as they had Seven Macaw; they trick them into climbing a tree/pole that grows taller and taller until the older brothers, trapped at the top, are turned into howler monkeys. Seven Macaw and the monkeys were the embodiment of the North Celestial Pole and its constellations. The monkey brothers might be understood to signify the old order and its celestial polar religion. The tale may reflect a societal conflict between an entrenched priesthood with a monopoly of esoteric knowledge and a more egalitarian class with an agricultural solar religion. Such a morality play may be illustrated at Izapa.

Some centuries earlier at Oxtotitlan, Guerrero, a north-facing enthroned man wore the wings and headdress of the harpy eagle, Principal Bird Deity, and enacted the turning of the circumpolar constellations about his own polar body. At La Venta imagery of the howler monkey, the harpy eagle, and magnetic iron ore mirrors of the night was concentrated on the south-north axis in the restricted northern Group A, while the circumpolar metaphor was portrayed by figures circling the standing ruler on Stela 2 in front of the Great Pyramid. At Izapa the plan of the site and an axial northern stela with the descending God C–Principal Bird Deity also reflect this ancient North Celestial Pole religion. God C is both the living and the divine expression of the polar paradigm. God C represented the people of an earlier time and the ancient royal lineage, its privileged wisdom, knowledge of calendars, the historic past, arts, and writing. Later, in the Classic period, a howler monkey is the wise god of the scribes, preserver of knowledge and tradition (Coe 1977). The Preclassic God C was the essence of the Principal Bird Deity, which represented the eternal northern realm of the deified ancestors, as it did a millennium later for the Classic Maya.

NOTES

1. This quadripartite association is documented as long as a millennium earlier in the Early Classic Tomb 12 at Rio Azul, Guatemala. There, each of the four walls is designated according to its cardinal direction by two painted glyphs. In each case, the head of God C prefixes the direction (Coggins 1988b, fig. 1).
2. For a discussion of north as cardinal direction and/or as up, see V. Bricker (1983, 1988), Closs (1988a, 1988b), and Coggins (1980, 1988a, 1988b).
3. Ruud van Akkeren (1998), in the paper “The Monkey and the Black Heart,” identifies Polaris with the “raised up Sky Place,” the “House of the North,” and the eight partitions of the sky at Palenque and in Aztec Late Postclassic period (A.D. 1300–1519) monkey images. These he associates with depictions of black monkey gods in the Maya Madrid Codex. He explores connections with the two monkeys in the epic known as the *Popol Vuh* and demonstrates their ethnohistoric and modern roles in highland Guatemalan ritual.
4. Lawrence Bardawil (1976) devised the useful term “Principal Bird Deity” for this divine bird, with reptilian characteristics, that presides over the Maya cosmos from the Preclassic through Classic periods—exemplified by Seven Macaw in the *Popol Vuh*.
5. Several scholars read To565 as *ta*, referring to a celestial location (Macri and Looper 2003, 208). In the Cordemex Yucatec language dictionary *ta* means “stone knife” (Barrera Vásquez 1980, 748). Together these suggest the reflective stone mirrors that signify deity.
6. No complete drawing or good photograph of this monument is available, so in the accompanying drawing by Benjamin Vining incised designs visible in published photographs are shown with those copied by Drucker from the front of the figure (Drucker 1952, fig. 53, plate 62). Beatrice de la Fuente (1973, 71) describes a tail on the back side and narrow crossed bands at the right side of the forehead that are not visible in any photograph.
7. Monument 13, immediately and axially in front of Mound A-2, represents what is likely a traveling long-distance trader with staff, whereas Monument 12, at the center point of the court, apparently represents God C, who is later identified as God of the North as well as of merchants.
8. Julia Guernsey (1997, 78, 79) identified this head as *tzuk* (stomach, partition) and, as in this chapter, the North Celestial Pole and cosmic pivot.
9. Monuments in Group B with emergence or rising themes include Misc. Monument 2, where a figure emerges or is born from a monster maw. In front of Mound 30, axial Stela 24 and Altar 20 may show a levitating individual and airborne bird. Stela 10, according to Norman (1976, 109–12), involves the birth (emergence) of the Hero Twins. Stela 9, on the group axis, depicts a possible flying figure with a curved instrument.

Stela 50 may show the heliacal rise of Venus from the underworld; Stela 11, the Sun emerging from the earth. Stela 28 depicts the emergence of an insect from its chrysalis (all illustrated in Norman 1973).

10. Lowe et al. (1982, 37, 40) noted important differences between Groups B and A that suggest “moiety concepts” as well as contrasting themes such as male/female, east/west, day/night.
11. Julia Guernsey (1997, 149, 162; 2006, 80) also noticed this similarity and discusses Stela 4 as a depiction of avian shamanic transformation.
12. Western lines added to the constellations probably do not correspond to those seen by ancient Mesoamericans.

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6

A Seasonal Calendar in the Codex Borgia

SUSAN MILBRATH

The Codex Borgia records a unique narrative from Central Mexico that has been studied by scholars for more than 100 years. At the turn of the last century, Eduard Seler ([1904–1909] 1963) wrote an extensive commentary on the Codex Borgia that continued to have an impact well into the late twentieth century after it appeared in a Spanish translation. He correctly identified Venus as the most important actor in the narrative on Borgia pages 29–46 (Milbrath 2007), but some recent studies have questioned his interpretation of the imagery as a Venus narrative, proposing instead that the eighteen-page sequence represents a mythological narrative of creation cosmology (Boone 2007).

This chapter explores a new interpretation of the narrative that builds on Seler's ([1904–1909] 1963) original findings, but also incorporates a detailed study of seasonal variations in the imagery of plants and animals and the Central Mexican festival calendar, as well as recent evidence from analysis of dated passages in the Codex Borgia. With this new approach it has become evident that the eighteen-page sequence refers to "real-time" astronomical events that are placed in a seasonal context using the annual festival cycle as a chronological framework (Milbrath 2007, 2013). Mythological events represented in these seasonal festivals evoke an ancient religious narrative, much like the annual cycle of rituals in the Christian church reenacting the birth and resurrection of Christ in the context of seasonal events (Milbrath 2013, 18, 107). Like religious calendars

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worldwide, the Codex Borgia represents an annual cycle that combines mythohistoric religious beliefs and astronomy in the framework of the seasonal cycle. As noted by Michel Graulich (1981, 48–49), the *veintenas* (20-day “months”) reenact a complex mythological cycle, most notable in the festival of Panquetzaliztli, which annually dramatizes the myth of Huitzilopochtli’s birth. Pedro Carrasco (in Graulich 1981, 50) notes that the yearly cycle in relation to agriculture and other human activities was the major determinant of the Aztec world view and that “the festivals of the Aztec year were in perfect agreement with the solar year at the time of the Spanish conquest” (see also Carrasco 1976).

INTRODUCTION

The Codex Borgia originated in Puebla-Tlaxcala Valley, where Nahuatl was spoken, as it was in the nearby Aztec capital of Tenochtitlan (Milbrath 2013, 1–3). The seasonal cycle represented in the Borgia is set in the framework of the Central Mexican festival calendar, consisting of eighteen *veintenas* (20-day periods) and the Nemontemi period of 5 days, totaling 365 days. Central Mexican festival calendars share many elements, including festival names, ceremonies, and deities honored in specific festival periods.¹ Well-documented in Aztec codices of the Colonial period, the eighteen *veintena* festivals are of paramount importance in terms of seasonal imagery in Central Mexico (Broda de Casas 1969, 1982, 1983). Priests dressed as gods reenacted these seasonal festivals, but the gods themselves perform these rituals in representations of the festivals in Aztec codices and the Tlaxcalan Codex Borgia.

The *veintena* festivals in the narrative on Borgia 29–46 appear in an abbreviated form because the festival cycle serves primarily as a chronological framework for astronomical events featuring Venus and the Sun and Moon. Festivals similar to those pictured in Colonial Aztec sources are not easy to recognize in this context, but the central image on at least six pages (33, 37, 40, 44, 45, and 46) seem to depict a corresponding seasonal festival represented at an appropriate interval (Milbrath 2007, 2013, 30). Placing the eighteen-page narrative in the context of the annual cycle means that each page represents a 20-day *veintena*, except for page 31, which incorporates a 25-day period (the Izcalli festival and the Nemontemi). This chronological framework helps place the Codex Borgia narrative in relation to the seasonal cycle, which is also evident in a clear contrast between the rainy and dry seasons in the imagery, and seasonal flora and fauna that change throughout the sequence.

REAL-TIME ASTRONOMICAL EVENTS

Before analyzing the seasonal cycle, I would like to acknowledge that Anthony F. Aveni (1999) first explored the possibility that certain Borgia almanacs with calendar round dates (year sign with day sign) depict astronomical events that can be dated in historical context. He tested whether real-time astronomical events were recorded with calendar round dates in weather almanacs on Borgia 27–28. Victoria Bricker (2001) and Christine Hernández and Bricker (2004) carried this research further, focusing on the relationships between the dates and changing weather patterns. My own research, conducted with Chris Woolley, has demonstrated that weather patterns depicted on Borgia 27 are confirmed by climate data encoded in tree-ring records from Douglas fir in Puebla (Therrell et al. 2004; Therrell et al. 2006; Woolley and Milbrath 2011). Most recently, this research has integrated records from the Maya area (Bricker and Milbrath 2011).

Ethnohistorical sources record a drought followed by a plague of rats in 1506, the year 1 Rabbit in the Aztec calendar (Quiñones Keber 1995). Fifteenth-century tree-ring records from Puebla confirm this drought (Woolley and Milbrath 2011). Rats attacking maize during the 1506 drought are also shown in a 1 Rabbit year on Borgia 27 (figure 6.1, lower left). Thirteen years earlier, in the year 1 House, we see maize fields flooded by too much rain (figure 6.1, upper left), a weather pattern also apparent in tree-ring records for that year, 1493 (Woolley and Milbrath 2011). Moving back another thirteen years to 1480, the image on the upper right of Borgia 27 shows the year 1 Flint with a sunny sky and a single puddle of rainwater (figure 6.1, upper right). This suggests that seasonal rainfall ended abruptly, conditions that are confirmed by comparing early and late wood tree-ring records for that year (Woolley and Milbrath 2011). Our research also points out that these weather conditions can cause grasshoppers to morph into locusts, evoking the swarm of locusts attacking the maize in the image on Borgia 27 in the year 1 Flint. The year 1 Reed, pictured on the lower right of Borgia 27 as the first year in the 52-year cycle represented by the dates in the four quadrants of Borgia 27, shows robust maize sprouting from the Earth Monster in 1467. Reliable tree-ring records for Central Mexico currently do not extend back to 1467, but the imagery on Borgia 27 suggests that this year was ideal in terms of rainfall and maize yields.

The year 1467, recorded on Borgia 27, also corresponds to a sequence of events linking the cycles of Venus and the Sun and Moon. Venus was visible as the Morning Star throughout the growing season during the year 1 Reed (1467), the year represented with favorable conditions in terms of rainfall and the maize crop.² The last visibility of Venus as the Evening Star occurred in

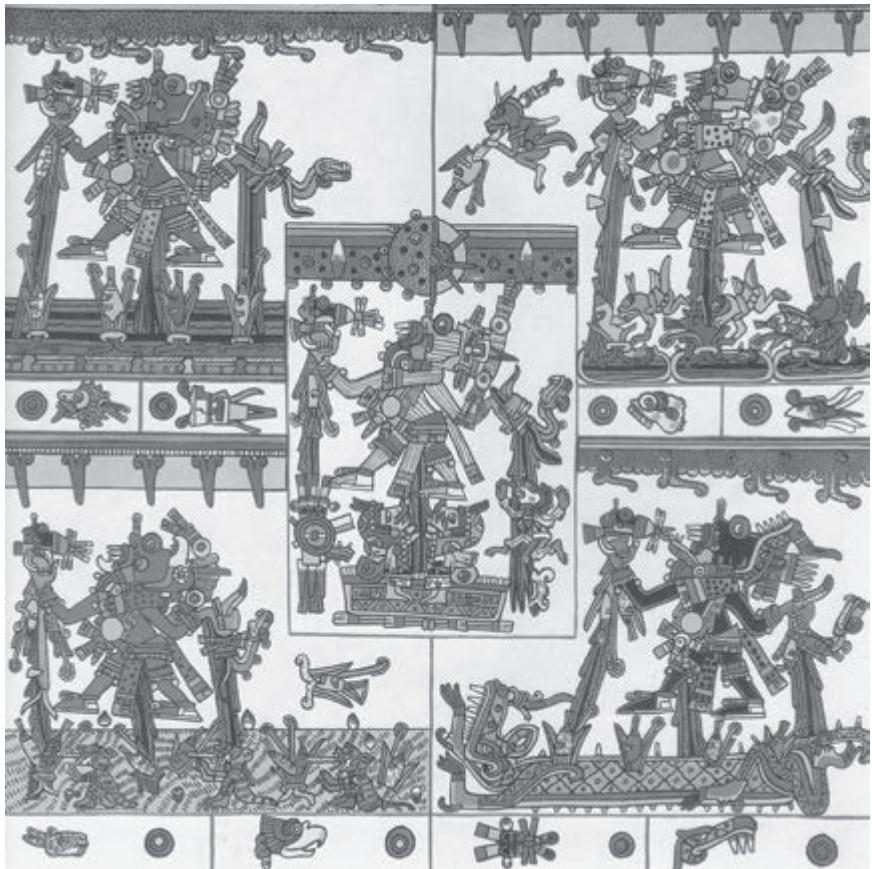


FIGURE 6.1. *Borgia 27* shows the cycle of 52 years, with changing weather affecting the fortune of the crops (after Byland 1993).

March 1467, corresponding to the first date on table 6.1. The second occurrence of 1 Crocodile 1 Reed (260 days later) may actually be of equal or greater significance, for it marks the last visible Morning Star when the moon was full on the winter solstice.

SEASONALITY IN THE NARRATIVE ON BORGIA 29–46

Weather almanacs on Borgia 27–28 also serve as a preface for Borgia 29–46, which records a narrative sequence depicting Venus imagery in the context of the annual festival cycle and the seasonal cycle of plants, animals, and ritual

TABLE 6.1. Borgia 27 Julian Dates and Corresponding Astronomical Events

27 LR	1 Reed	1 Crocodile	Mar. 26, 1467	Venus E-last
27 LR	1 Reed	1 Crocodile (2nd)	Dec. 11, 1467	Winter solstice, full moon, and Venus M-last
27 UR	1 Flint	1 Death	Mar. 22, 1480	
27 UR	1 Flint	1 Death (2nd)	Dec. 7, 1480	Venus E-first
27 UL	1 House	1 Monkey	Mar. 19, 1493	
27 UL 1	1 House	1 Monkey (2nd)	Dec. 3, 1493	
27 LL 1	1 Rabbit	1 Vulture	Mar. 16, 1506	
27 LL 1	1 Rabbit	1 Vulture (2nd)	Dec. 1, 1506	Full moon

Source: Milbrath 2013, tables 2.5 and 3.1.

LL = Lower Left, LR = Lower Right, UL = Upper Left, UR = Upper Right; E-first = first visibility of the Evening Star; E-last = last visibility of the Evening Star; M-last = last visibility of the Morning Star.

activities during the year (Milbrath 2013). The seasonal patterning of the narrative analyzed here is based on an understanding of the chronological framework I developed over more than twenty years of research on the astronomical events and festivals portrayed on Borgia 29–46 (Milbrath 1989, 2000, 2007, 2013).

Study of the patterning of astronomical events indicates that the narrative on Borgia 29–46 begins with the disappearance of the Evening Star on January 2, 1496, during the festival of Atemoztli, the festival period corresponding to Borgia 29 (figure 6.2a). The narrative continues with the emergence of the Morning Star on page 30 (figure 6.2b). In fact, the sequence of eighteen pages shows all four phases of Venus, from its disappearance as Evening Star on Borgia 29 to its reemergence as Evening Star on Borgia 46, the last page in the sequence. A change in the alignment of the screenfold images on pages 29–46 indicates that these pages are read from top to bottom, and they all seem to form visual pairs that represent paired *veintenas*, labeled as *a* and *b* in figures 6.2–6.10 (see also Milbrath 2013, fig. 2.2). This pairing is evident through formal analysis, because the pages either have a similar format, as on pages 29–30, where both have a strong central circular design framed by a border (figures 6.2a, b), or they show narrative events that carry the action from one page to the next, as on Borgia 37–38, where pathways connect the two pages, or on Borgia 39–40, where the Earth Monster is spread out over two pages (figures 6.6a, b and 6.7a, b).

Although astronomical events dominate the imagery on Borgia 29–46, a number of festivals can be identified at appropriate intervals, assuming that



FIGURE 6.2. (a) Left, *Borgia 29*, the first page of the eighteen-page narrative, depicts a skeletal Venus god on a container of burned ashes, symbolizing the disappearance of the Evening Star as during *Atemoztli* on January 2, 1496; (b) right, *Borgia 30* shows a resplendent rayed disk with *Ehecatl* serpents, representing the reemergence of Venus as the Morning Star on January 12, 1496 (after Milbrath 2013, fig. 4.2).

each page corresponds to the period of time represented by the eighteen festival periods, or *veintenas*, and the Nemontemi (Milbrath 2013).³ For example, page 31 references events in the festival of Izcalli, characterized by bathing rituals (figure 6.3a; Milbrath 2013, 24, plate 3). *Borgia 32* refers to the festival of Cuahuitehua honoring the Tlaloque, but these gods are shown in the border because the central image focuses on a decapitation scene that may embody an annual celebration of the origin of the gods, encoded in Central Mexican myths (figure 6.3b; Milbrath 2013, 80, plate 4). Representing a period that falls 20 days later, *Borgia 33* depicts Xipe sacrificed on a round stone on a temple platform (figure 6.4a), recalling Aztec images of *Tlacaxipehualiztli*, the spring equinox festival in March (Boone 1983; Quiñones Keber 1995; Milbrath 2013, 26). *Borgia 33* also shows the sacrifice of Tlaloc in front of the temple, a symbol of the lack of rainfall in March, a scene repeated on *Borgia 34* during April (figure 6.4b; Milbrath 2013, plates 5–6). The seasonal cycle may also be referenced on *Borgia 35*, which shows the wind god mask at a time that the winds are becoming more prominent in late April to early May, but the main focus is on events involving Venus and the Moon (figure 6.5a; Milbrath 2013, plate 7). *Borgia 36* features undulating *Ehecatl*-Quetzalcoatl serpents as symbols of the rising winds that bring rainfall in May during *Toxcatl* (figure 6.5b; Milbrath 2013, plate 8). According



FIGURE 6.3. (a) Left, Borgia 31 depicts bathing rituals during the Izcalli festival in February; skeletal vegetation goddesses represent dormant plants and “dead” maize in the dry season; (b) right, Borgia 32 refers to the festival of Cuahuitlehua, honoring the Tlaloque (shown in border), with the central image focusing on a decapitation scene representing lunar imagery (after Milbrath 2013, fig. 4.3).

to the *Relaciones Geográfica*, the winds are notable at this time of year in Central Mexico because the prevailing winds change direction (Acuña 1986, 233–35).

In table 6.2, Borgia 36–44 cover a span from May through October, correlating with the rainy season (figures 6.5b–6.9b).⁴ These pages show seasonal imagery depicting bees, butterflies, hummingbirds, bats, and the flowers they feed on during the rainy season. Flowered temples and flowered borders appear only on Borgia 36, 37, 42, and 44, pages that correlate with the rainy season (Milbrath 2013, plates 8–16). In keeping with this seasonal patterning, on Borgia 44 a bat surrounded by hummingbirds pours flowery blood on a hummingbird avatar of Quetzalcoatl and a flowering tree sprouting from Xochiquetzal’s body (figure 6.9b). Bees and bee deities, butterflies, and hummingbirds all appear only on pages 36, 38, 40, and 44, representing the rainy season, when blooming flowers nourish these creatures (Milbrath 2013, plates 8, 10, 12, 16). There are variations in the representation of hummingbirds (*Trochilidae*) in the Borgia that warrant further study, for different species may be represented, as on Borgia 44, where four different hummingbirds surround the bat figure (figure 6.9b). Generally, there are two different patterns for hummingbirds in the Central Highlands, with resident hummingbirds breeding in the summer (rainy season) and withdrawing to the lowlands in the winter

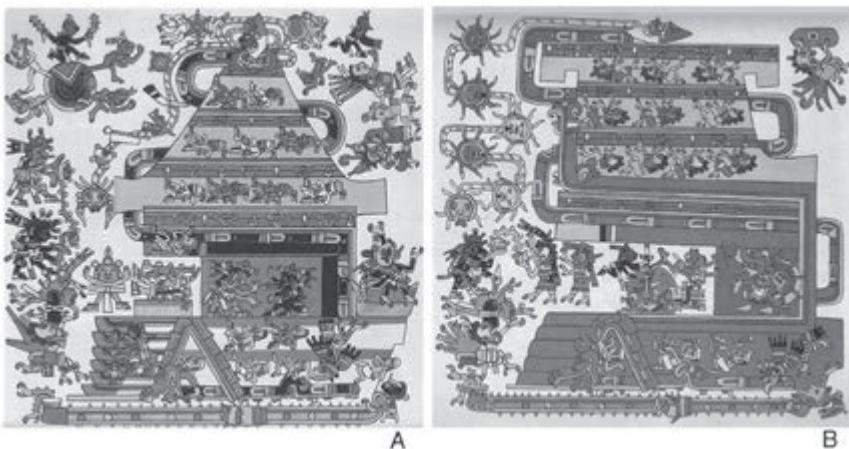


FIGURE 6.4. (a) Left, *Borgia 33* illustrates the sacrifice of Xipe Totec in front of the temple during the festival of *Tlacaxipehualiztli*, correlating with the March equinox. Inside the temple, Black Quetzalcoatl represents Venus bestowing power on a god specifically representing the Morning Star, *Tlahuizcalpantecuhtli* (“Lord of Dawn”), at a time that the Morning Star had reached its maximum altitude. A fire serpent on the stairs and the sacrifice of rain god *Tlaloc* mark the height of the dry season in March. (b) Right, *Borgia 34* repeats the sacrifice of *Tlaloc* and fire-serpent imagery on *Borgia 33*. The skeletal maize goddess on the upper right here and on the preceding page (33) represents maize in its underworld aspect during the dry season in April, and on the lower left a skeletal goddess with a sheave of grass and war banners represents the death of grass in the dry season, the season of warfare (after Milbrath 2013, fig. 4.4).

(dry season); a second population of migrants from the north breed in North America and winter in Central Mexico (Howell and Webb 1995, 14, 391–92).⁵

Imagery of maize is also prominent only on pages correlating with the rainy season (Milbrath 2013, 31). *Borgia 37* shows the first offering of green maize in June (figure 6.6a). On page 38 a giant maize cob represents the ripening maize fields in July (figure 6.6b). On page 43 a border of maize depicting the fields ready for harvest in October surrounds the central scene showing maize offered to nourish the gods (figure 6.9a). In contrast, during the dry season maize is “dead,” hence we see maize carried by death goddesses, deities who are also shown bearing other plants that are dead or dormant during the dry season (Byland 1993, 31, 33, and 34) (figures 6.3a, 6.4).

Fire-serpent images during March and April in the narrative on pages 33 and 34 correlate with the dry season, as do the fire serpents on page 46, a page



FIGURE 6.5. (a) Left, Borgia 35 depicts Stripe-Eyed Quetzalcoatl for the first time in the narrative, shown here on the ball court in May at a time when Venus was descending in the morning sky as the first rains begin; (b) right, Borgia 36 shows the rising winds represented by Ehecatl serpents during May, the first month of the rainy season, accompanied by flowers, butterflies, and hummingbirds associated with the rainy season (after Milbrath 2013, fig. 4.6).

corresponding to Panquetzaliztli in December (figures 6.4a, b and 6.10b; table 6.2). These serpents generally symbolize the dry season, but in one case the fire serpent appears as a sign of temporary drought (see below).

SEASONAL CEREMONIES IN BORGIA 29–46

Having outlined the seasonal plants and animals in the narrative, we can turn to a more detailed study of the seasonal cycle. The transition to the rainy season on Borgia 36 is apparent in imagery of starry Ehecatl serpents, representing night winds that rise up to bring the rain during the festival of Toxcatl at the onset of the rainy season in May (figure 6.5b; Milbrath 2013, plate 8). Borgia 36 depicts the primary deity honored in Toxcatl, Tezcatlipoca, a god whose dark mirror controlled rainfall (Nicholson 1971, table 4).⁶ Wearing an Ehecatl mask, Tezcatlipoca stands on a funerary bundle that emits wind serpents and rainy-season creatures, such as hummingbirds and butterflies, along with maize, flowers, and other plants that come to life with the onset of seasonal rainfall in May.

Page 37, the next page in the narrative, represents the period of Etzalcualiztli in June (figure 6.6a; Milbrath 2013, plate 9). This page refers to the seasonal

TABLE 6.2. Dates for Festivals in 1495–1496 and Their Relationship with Borgia 29–46

<i>Page</i>	<i>Festival Number and Aztec Dates*</i>	<i>Named Festival in Nicholson (1971, table 4)</i>
29	16th December 17–January 5	Atemoztli “Decent of Waters”
30	17th January 6–January 25	Tititl “Contraction?”
31	18th + 5 January 26–February 19	Izcalli + Nemontemi “Growth” + “Useless”
32	1st February 20–March 10	Cuahuitehua “Raising of Poles”
33	2nd March 11–March 30	Tlacaxipehualiztli “Flaying of Men”
34	3rd March 31–April 19	Tozoztontli “Small Vigil”
35	4th April 20–May 9	Hueytozoztli “Great Vigil”
36	5th May 10–May 29	Toxcatl “Dry Thing?”
37	6th May 30–June 18	Etzalcualiztli “Eating of Etzalli”
38	7th June 19–July 8	Tecuilhuitontli “Small Feast Day of the Lords”
39	8th July 9–July 28	Hueytecuilhuitl “Great Feast Day of the Lords”
40	9th July 29–August 17	Miccaihuitontli “Small Feast Day of the Dead”
41	10th August 18–September 6	Hueymiccaihuitl “Great Feast Day of the Dead”
42	11th September 7–September 26	Ochpaniztli “Road-Sweeping”
43	12th September 27–October 16	Pachtontli “Small Pachtli”
44	13th October 17–November 5	Hueypachtli “Great Pachtli”
45	14th November 6–November 25	Quecholli “Precious Feathers”
46	15th November 26–December 15	Panquetzaliztli “Raising of Banners”

*The same festivals are known from Tlaxcala and Teotitlán del Camino in Oaxaca (Caso 1967, table 10; Paso y Troncoso 1905, 217–20). Dates given in the Julian calendar are for the Aztec years 1495–1496, adjusted from dates for 1519–1520 (Nicholson 1971, table 4). All the festival names are translations from Nicholson’s table 4, except for the term *Nemontemi*, which is from Durán (1971, 469).

festival honoring Tlaloc, when green maize was first available for consumption (Milbrath 2013, 22, 29). The rain god Tlaloc has not produced adequate rainfall, for his water pot issues flames rather than rain. This may be a sign that the rains are delayed this year. But rain is imminent because Tlaloc steps onto a stream of clouds, and, at the bottom of the page, the canine avatar of Xolotl carries the fire serpent into the underworld, indicating the drought has ended.⁷

Next, on page 38, we see an underworld aspect of Xolotl with a bald cypress tree, with a drum to signify that it is the “drum tree” (*abuehuete*), here beginning to leaf out as the rainfall increases in late June (figure 6.6b; Milbrath 2013, 87). Xolotl reaches up with a digging stick to pierce Tlaloc, who offers his life blood to nourish the fields, symbolized by a giant maize cob, imagery appropriate to the festival of Tecuilhuitontli honoring Tlaloc (Milbrath 2013,

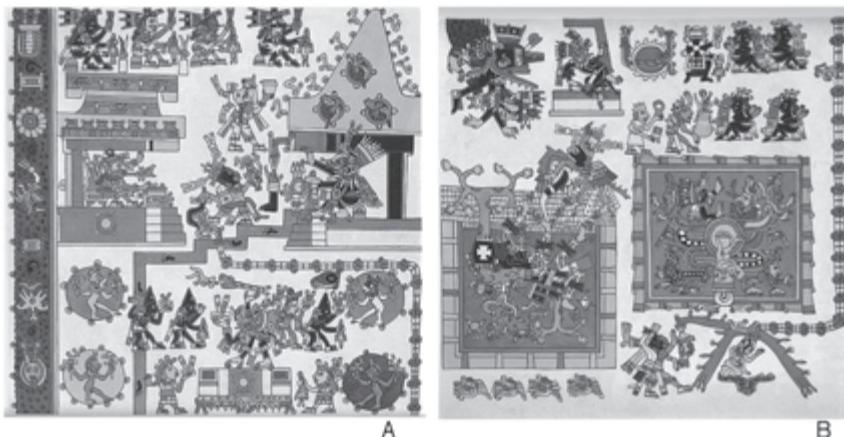


FIGURE 6.6. (a) Left, Borgia 37 depicts a flowered temple of the sun representing the summer solstice and Xolotl carrying the fire serpent into the underworld as a sign of the end of drought. The first green maize offering accompanies Tlaloc, who steps onto a cloud stream as the heaviest rains begin to fall. (b) Right, Borgia 38 represents Stripe-Eyed Quetzalcoatl descending as the Morning Star of the rainy season, with rainfall streaming up from Tlaloc's water jar to bathe the rainy-season Venus god. A newborn maize child represents maize maturing in the field, and a large maize cob represents the maize fields nurtured by Tlaloc, who offers his lifeblood to nurture the crop (after Milbrath 2013, fig. 4.7).

87–88, plate 10). Tlaloc reappears on the lower right of page 38, holding a Tlaloc-faced water jar that produces abundant rain. Another seasonal reference to maize on Borgia 38 is represented by a baby emerging with a maize cob, an image that shows the milpa has “given birth” to the principal maize crop in June.

On page 42, a solar god appears in a flowered temple at the fall equinox in September, repeating a scene shown on Borgia 37 at the summer solstice (figures 6.6a, 6.8b). This god may be the “flower prince,” Xochipilli, who is associated with flowers and butterflies and apparently depicts the sun during the rainy season in the Borgia narrative (Milbrath 2013, 50). The summer solstice and fall equinox bracket the period of heaviest rainfall, just as the winter solstice and spring equinox bracket the months with the least rainfall.

On Borgia 44, the hummingbird aspect of Quetzalcoatl is a seasonal manifestation of Venus, and the bat figure surrounded by hummingbirds also alludes to the rainy season (Milbrath 2013, 29–30). The central image shows Xochiquetzal with a flowering tree, which seems to allude to the mythic

origin of flowers (Boone 2007, 204). Study of the festival calendar suggests that Xochiquetzal's myth was reenacted annually in Hueypacthli, and her cult was the focus of special attention every eight years during the ceremony of Atamalcualiztli, which coincided with Hueypacthli during the time the Borgia calendar was created (figure 6.9b; Milbrath 2013, 29–30, 95, 119n49).⁸ Xochiquetzal is a lunar goddess linked with flowers, butterflies, and the rainy season, and her role as bride of the Sun God suggests she may represent the new moon “joined” with the sun (Milbrath 2013, 51–52). In the Borgia narrative Xochiquetzal seems to symbolize the new moon on page 44, for her torso is covered by a sun disk with radiant yellow rays, indicating the conjunction of the moon with the sun (Milbrath 2000; 2013, 94).

Page 45 depicts the hunting god Camaxtli, honored during Quecholli in November at the onset of the dry season, a time of war and hunting (figure 6.10a; Milbrath 2013, 30). Camaxtli holds a shield, a war banner, a dart thrower, and a net for carrying game. Behind him, war banners crown a tree with dark mirrors, symbolizing the dry season as a time of warfare. Dry-season imagery relating to warfare also appears on Borgia 29, which features a set of war banners in the month of December, after the main agricultural cycle has come to a close (figure 6.2a).

Sahagún mentions pulque consumption during a number of different months in book 2, which focuses on the *veintena* ceremonies, but since pulque had to be consumed when freshly made, there may have been an optimal time of year for consumption based on patterns of tapping the maguey. It is noteworthy that the only image of pulque in the Borgia sequence occurs on page 45, corresponding to the beginning of the dry season, the optimal time for pulque production (Carrasco in Graulich 1981, 50). According to Pedro Carrasco (1976, 280), the top was cut off maguey cactus, when it was “castrated” to tap the *aguamiel* used to make pulque during Pachtontli. This month dated to September 22 through October 11 in 1519, at the end of the rainy season (Milbrath 2013, table 2.3), so the image of a pulque jar full of pulque in the next month (Quecholli) seems highly appropriate in the Borgia sequence (figure 6.10a).

The yearlong narrative ends on page 46 during Panquetzaliztli (November 26–December 15 Julian; December 5–24 Gregorian; table 6.2), showing multiple images of the fire serpent and fire ceremonies characteristic of that festival (figure 6.10b). Quetzalcoatl drills a fire on Xiuhtecuhltli's fire serpent to fortify the sun in its journey through the underworld during the longest night of the year on the winter solstice.⁹ It is noteworthy that the winter solstice and spring equinox both are associated with fire-serpent imagery appropriate to the dry season (Byland 1993, 33, 46).

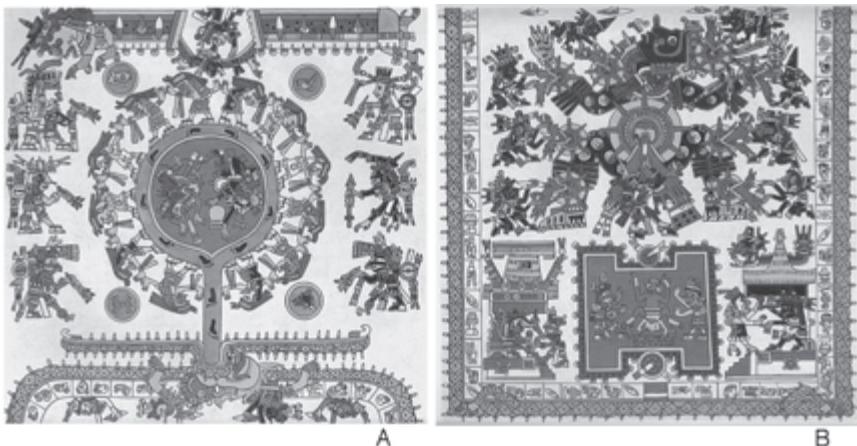


FIGURE 6.7. (a) Left, Borgia 39 illustrates Stripe-Eyed Quetzalcoatl continuing his descent as Venus moves lower on the eastern horizon, following a path into the jaws of the Earth Monster. (b) Right, Borgia 40 depicts Stripe-Eyed Quetzalcoatl temporarily drawn into the underworld when day turns to night during the total eclipse. He is the most prominent of the Venus gods attacking the Sun during the solar eclipse in August 1496 (after Milbrath 2013, fig. 4.8).

THE ROLE OF VENUS IN THE NARRATIVE

Images of Venus events and a solar eclipse help link Borgia 29–46 specifically with the year 1496. Page 40 shows a solar eclipse with a pie wedge slice cut out of the sun, much like Aztec representations of solar eclipses (figure 6.7b). Testing all the Late Postclassic period eclipse dates recorded in ethnohistorical sources relating to the period of the Aztec empire (A.D. 1300–1519) provides strong evidence that page 40 depicts a solar eclipse on August 8, 1496, the only total eclipse recorded in these Aztec sources (Milbrath 2007; 2013, 44). This eclipse image features multiple avatars of Quetzalcoatl attacking the Sun because Venus was seen alongside the Sun during the eclipse (Milbrath 2013, sky map 6).

Even though Borgia 29–46 shows only one year, it depicts Venus in all four phases, beginning with the disappearance of the Evening Star in January 1496 and ending with its reappearance as the Evening Star in December 1496. The disappearance of the Evening Star during inferior conjunction on page 29 is symbolized by a skeletal Venus god on smoldering ashes in a *cuauhxicalli*, a vessel used for offering the hearts of sacrificial victims (figure 6.2a). This evokes a text in the *Anales de Cuauhtitlan*, which recounts how Quetzalcoatl

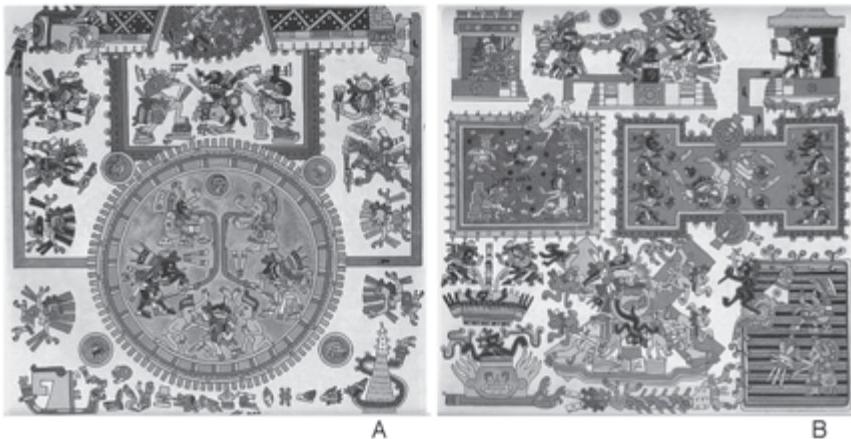


FIGURE 6.8. (a) Left, Borgia 41 portrays Stripe-Eyed Quetzalcoatl continuing his descent along the path that leads to a scene of bloodletting associated with the last visibility of the Morning Star, shown as a giant radiant disk at a time when the planet is especially brilliant near the horizon. (b) Right, Borgia 42 depicts a flowered sun temple housing a solar god (Xochipilli?) on the fall equinox and Stripe-eyed Quetzalcoatl as the sacrificer of a spotted Venus god, who tumbles into the underworld through a ball court that leads to the open jaws of the Earth Monster (after Milbrath 2013, fig. 4.9).

traveled from west to east and set himself on fire, spending eight days in the underworld before he emerged as Tlahuizcalpantecuhtli, the god of the Morning Star (Bierhorst 1992; Milbrath 2013, 16, 77). The skeletal Venus god and his burned ashes (or burned heart) represent a brief period of invisibility during inferior conjunction. Next we see a brilliant rayed disk on Borgia 30 representing Venus as it reemerges as the resplendent Morning Star in January 1496 (figure 6.2b).

On page 42 the planet's disappearance in superior conjunction is shown by a Venus god portrayed as a sacrificial victim who tumbles into the underworld through a ball court that leads to the gaping jaws of the Earth Monster (figure 6.8b). The long underworld sojourn in superior conjunction extends through Borgia 45, where we see the Morning Star in the guise of Camaxtli, the Tlaxcalan counterpart of Tlahuizcalpantecuhtli, but here in a skeletal aspect because the Morning Star is deceased (figure 6.10a). The last scene on the bottom of page 45 refers to Quetzalcoatl preparing to reemerge as the Evening Star. He wears a Venus glyph but is still "under wraps," covered by a funerary bundle framed by the decapitated heads of the deceased Morning Star. Here

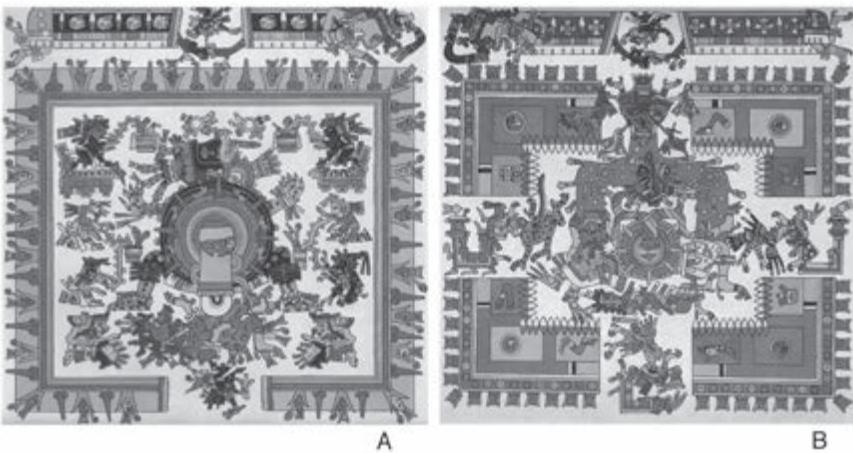


FIGURE 6.9. (a) Left, *Borgia 43* shows a border of solar rays alternating with ripe maize during October that is harvested as an offering to the gods inside the frame representing the realm of the sun. The central image shows the canine *Xolotl*, combined with *Quetzalcoatl*, here covered with a starry orb representing the moon, which is in turn covered by a sun disk to show conjunction with the Sun. (b) Right, *Borgia 44* pictures a flowered border framing *Xochiquetzal*, who is covered with a solar disk to represent the new moon in conjunction with the sun. The hummingbird aspect of *Quetzalcoatl* and the bat god pouring blood are both rainy-season deities. The flowering tree alludes to the mythic origin of flowers celebrated as part of the seasonal cycle of festivals (after Milbrath 2013, fig. 4.10).

Quetzalcoatl issues bloody diarrhea, symbolizing meteor showers visible to the west in the evening sky during November 1496 (Milbrath 2013, 96, plate 17). Then on page 46 we see Venus is transformed by fire, when *Quetzalcoatl* emerges from a boiling pot and drills a fire on the back of a fire serpent in his role as the newly visible Evening Star (figure 6.10b; Milbrath 2013, 98, plate 18).

In addition to its transformation in four different phases, the narrative also depicts the changing position of Venus in the sky over the course of a year. Wearing a headdress representing the rayed Venus orb, Black *Quetzalcoatl* is enthroned high atop a temple on page 33, where he gives his powers to *Tlahuizcalpantecuhtli*, the “lord of dawn” (figure 6.4a). They both share costume elements because they represent two different aspects of Venus, one specifically alluding to the Morning Star and the other embodying the planet itself. These paired Venus gods on *Borgia 33* appear on the top of a pyramid temple in March of 1496, when Venus had reached its maximum altitude in the morning sky (February 27, 1496) (Milbrath 2013, 81).

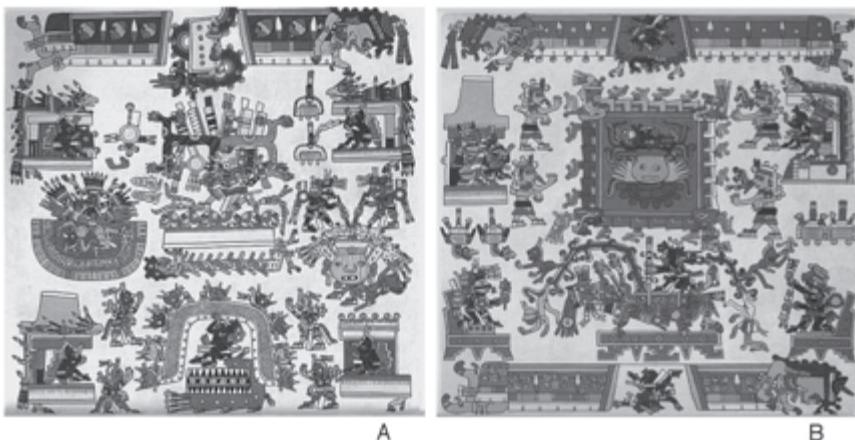


FIGURE 6.10. (a) Left, Borgia 45 depicts *Quecholli* in November at the onset of the dry season, honoring *Camaxtli*, the god of the hunt, here fused with a skeletal aspect of Venus symbolizing the Morning Star invisible in the underworld. War banners represent the dry season as the time of warfare. Wearing a Venus symbol, Venus-Quetzalcoatl is hidden from view in a funerary bundle that is framed by decapitated heads representing the deceased Morning Star. (b) Right, Borgia 46, shows the transformation of Venus by fire as Quetzalcoatl boils in a flaming jar in a temple precinct surrounded by fire serpents. He then reemerges as the newly visible Evening Star and drills a fire on the fire serpent during the December solstice festival in *Panquetzaliztli* (after Milbrath 2013, fig. 4.12).

Subsequently, we see that Black Quetzalcoatl on page 35 begins his descent down a path at a time that the Morning Star was slowly moving closer to the eastern horizon during the dry season in a period running from April 20 to May 9 in 1496 (table 6.2; figure 6.5a). Page 35 shows Quetzalcoatl accompanied by Tezcatlipoca (“smoking mirror”), who has a smoking mirror on his brow but also wears the wind god mask of Ehecatl-Quetzalcoatl. Tezcatlipoca is a lunar god in this context, probably representing the waning moon slowly descending to the eastern horizon during this *veintena*, when it joined the Morning Star (Milbrath 2013, 84–85). Apparently, this one-of-a-kind image (seen also on Borgia 36) shows that Tezcatlipoca takes on some of the Venus god’s attributes in the astronomical narrative to show their proximity in the sky.

The ball game scene at the bottom of page 35 introduces a new Venus avatar, showing Quetzalcoatl with a vertical stripe of face paint that runs through his eye (Milbrath 2013, 85). Stripe-Eyed Quetzalcoatl seems to represent a rainy-season aspect of Venus. Because the pages are read top to bottom, the

ball court scene on the bottom of the page refers to the latter part of the 20-day period on page 35, probably referencing the seasonal transition and possibly also the solar zenith at the end of the *veintena* on May 9 (table 6.2; Milbrath 2013, 85–86, plate 7). As the first rains began in May 1496, Stripe-Eyed Quetzalcoatl makes his first appearance as the rainy season aspect of Venus when the planet was seen descending in the morning sky.

With the onset of the heavy rains in May, Stripe-Eyed Quetzalcoatl appears repeatedly on the border of page 36 (figure 6.5b; Milbrath 2013, plate 8). He floats down a dark path at a time when the Morning Star was descending each night closer to the eastern horizon. On page 38, a nude figure of Stripe-eyed Quetzalcoatl is seen with rain clouds rising up from his body at the time of heavy rainfall during June (figure 6.6b; Milbrath 2013, plate 10). On page 39 his path of descent takes him into the jaws of the Earth Monster, as Venus descends closer to the eastern horizon (figure 6.7a; Milbrath 2013, plate 11). On the next page he moves into the nocturnal realm of the underworld in an image that represents only a temporary sojourn in darkness, when Venus was seen alongside the Sun during the total solar eclipse in August 1496 and day turned to night (figure 6.7b; Milbrath 2013, plate 12). Appearing among nine manifestations of Venus in the eclipse scene, Stripe-Eyed Quetzalcoatl takes the most prominent position in the center as he cuts open the largest solar disk on the darkened Sun during the eclipse. He wears a hummingbird costume because he takes the role of the hummingbird god honored during Miccaihuitontli (Milbrath 2007, 2013, 29). On Borgia 40, as on Borgia 33 and 35, multiple representations of Quetzalcoatl allude to different aspects of Venus.

On the next page (41), Stripe-Eyed Quetzalcoatl continues along a path of descent while Black Quetzalcoatl and a red-spotted Quetzalcoatl offer their blood in a giant disk representing Venus, which was now especially brilliant just above the horizon at dawn because it was close to the sun in the east (figure 6.8a; Milbrath 2013, plate 13). On page 42, Stripe-Eyed Quetzalcoatl sacrifices a red-spotted avatar of Quetzalcoatl, a scene representing the disappearance of the Morning Star during September (figure 6.8b; Milbrath 2013, plate 14). All the images on Borgia 35–42 representing Stripe-Eyed Quetzalcoatl correspond to a time when Venus was visible as the descending Morning Star during the rainy season (see note 5 and table 6.2; Milbrath 2013, table 4.2, plates 7–14).

One final image of Stripe-Eyed Quetzalcoatl appears in the border of page 43, where he is completely covered by a skeletal god who is positioned in the abdominal opening of the goddess of the Milky Way, an image representing Venus located in the underworld side of the Milky Way (Milbrath 2013, plate 15). This scene, taking place in October near the end of the rainy season, shows

Stripe-Eyed Quetzalcoatl as a rainy-season aspect of the planet, but one that is hidden from view as Venus in superior conjunction descended to the depths of the underworld (Milbrath 2013, 93).

SEASONAL PATTERNING

The narrative is loosely integrated with the seasonal cycle of festivals, beginning on page 29 with Atemoztli, just following the winter solstice, and closing on page 46 with Panquetzaliztli, the festival corresponding to the winter solstice. At least six *veintena* festivals are clearly referenced in the central images of the Borgia narrative (Byland 1993, 33, 37, 40, 44, 45, 46), and on other pages (Borgia 31, 32, and 38) there are also allusions to the corresponding *veintena* festival (Milbrath 2013, plates 3, 4, 10).

An avatar of the Sun God references a rainy-season aspect of the Sun housed in a flowered temple on the summer solstice and fall equinox on pages 37 and 42 (Milbrath 2013, plates 9, 14). These solar dates bracket the period of heaviest rainfall. In addition to the *veintena* festivals, there are also seasonal transformations of Venus represented in the Borgia narrative, as well as numerous references to the seasonal patterns of flora and fauna. Images of flowers and creatures active in the rainy season are seen only on pages 36–44, corresponding to May through October, and their absence can be noted on the remaining pages, all linked with the dry season. On pages referencing the dry season we see a different kind of imagery, featuring war banners, fire ceremonies, and skeletal vegetation goddesses, representing plants that have died or are dormant from November through April. On pages representing the dry season, the imagery also features fire-serpent temples on the spring equinox and winter solstice, as seen on Borgia 33 and 46 (figures 6.4a, 6.1ob; Milbrath 2013, plates 5, 18). These subtle details are part of a seasonal narrative that can be deciphered through detailed iconographic analysis.

The narrative on Borgia 29–46 records seasonal rituals and astronomical events portrayed by Venus gods who take on different avatars in relation to the corresponding seasons and changes in the phase and positioning of Venus in the sky. A similar interest in the seasonal cycles involving specific Venus phases is apparent on Borgia 27, a discovery first made by Aveni, whose seminal research on the Codex Borgia inspired me to study “real-time” astronomical events on Borgia 29–46 and the preface to this narrative on Borgia 27–28.

The recognition of dates associated with natural history events in the Post-classic codices is a recent development, providing a new path for understanding the content of codices in Mesoamerica. Mythology may play a part in the

veintena festivals portrayed in the Borgia, but myths do not appear to be the central subject of the events on Borgia 29–46. This narrative is in fact a record of an exceptional year, the year of the only total eclipse of the sun recorded for Central Mexico in Aztec sources (Aveni and Calnek 1999). Although not explored here in any detail, the narrative also includes images depicting observations of the moon throughout 1496, including representations symbolizing the new moon on Borgia 43 and 44 (Milbrath 2013, plates 15, 16). In this year, Venus disappeared as the Evening Star just following the winter solstice and cycled through inferior conjunction, Morning Star, and superior conjunction, and then reappeared as the Evening Star just prior to the winter solstice (Borgia 46). This reflects a great interest in coordinating the solar cycle with Venus events, an important element in the Central Mexican Venus almanac also evident in the Maya area (Milbrath 1999, 172).

The narrative on pages 29–46 tracks the seasons of the year and the solstices in relation to Venus phases and the lunar cycle, events that are clearly of interest in longer cycles of time, such as those seen in the preface to the narrative on Borgia 27–28 (figure 6.1; Milbrath 2013, fig. 1.5). Long-term weather patterns are apparently recorded in relation to the phases of Venus and the Moon in the Codex Borgia. The agricultural almanacs on Borgia 27–28 record dates that coordinate the seasonal cycles with observations of events involving Venus, the Sun and the Moon, the same pattern seen in the narrative on Borgia 29–46 (Milbrath 2013, plates 1–18). Page 27 focuses on variations in seasonal rainfall in relation to the fortunes of maize over the fifty-two-year cycle known as Xiuhmolpilli. Drought, flooding, and pest infestations are all represented in relation to a long cycle of time that can be considered a climate record coordinated with astronomical observations.

Prior to the conquest, Central Mexican codices lacked any inscriptions except for dates, so the artists used detailed visual imagery to provide records of the natural cycles and variation in climate and crops. Even though the events in this narrative focus on only one year, the images tell us that the rains came late in the year 1496. This year was apparently especially ominous for other reasons, for this was the year of the only total eclipse recorded in Aztec sources. The narrative and its preface seem to be natural history records compiled over 500 years ago by the people of Central Mexico, making them exceptionally important to our understanding of the ancient Mexican environment and world view.

Acknowledgments. My thanks go to Vicky and Harvey Bricker for reading the final draft of this paper and suggesting a few changes and corrections and, of course, to Tony Aveni for inspiring this research. And I am pleased to have

had the opportunity to collaborate with Anne, who has efficiently shepherded our book through its many phases, making the volume available only three years after the 2012 SAA conference honoring Tony.

NOTES

1. Tlaxcala had a festival calendar sequence very similar to that of the Aztecs, indicating a widespread Central Mexican tradition that may be quite ancient (Milbrath 2013, table 2.2).

2. Šprajc (1996, 42) argues that maize deities are connected with the Evening Star, but Johannes Neurath (2005, 91–92, 95n6.9) points out that among the Cora today in western Mexico cloud serpents that bring the first rains when the planting is about to begin represent the Morning Star, and he concludes that among some Mesoamerican traditions the Young Corn God should be identified as the Morning Star.

3. Many of the pages record sets of four day signs spaced at five-day intervals, all drawn from the 20 day signs used in the 260-day count (*Tonalpohualli*). The lack of numerical coefficients allows the same set of day signs to function in a variety of ways. Using the same set of day signs with different numeral coefficients allows placement of the festival calendar dates over the four-year sequence of yearbearers and the eight-year cycle of the Venus Almanac, as well as the 52-year *Xiuhmolpilli* (Caso 1971, 347; Milbrath 2013, 103–4).

4. A precipitation graph for Central Mexico shows that rainfall steadily increases in May and peaks in June (Hernández and Bricker 2004, fig. 10.3; Hernández 2006, fig. 3). The rainy season runs from May to the end of October, incorporating the summer solstice and fall equinox, representing the half-year when maize was growing. The dry season runs from November through April, a period that includes the winter solstice in December and the spring equinox in March, when the only maize available was the mountain maize or maize from irrigated crops (Milbrath 2013, 19–20, 116n12, 116–17n18).

5. A report published by Carlos Lara (2006) notes that the availability and quality of floral resources explains the temporal and spatial composition of the hummingbird community in Tlaxcala, which is composed of two resident hummingbirds, three altitudinal migrants, and three winter visitors. The plant species visited by hummingbirds in Tlaxcala differ throughout the year in terms of flowering intensity, nectar, and sugar characteristics, but the highest floral abundance occurs in May to October (the rainy season), with blooming peaks for the three preferred flowering plants: *Salvia elegans*, *Bouvardia ternifolia*, and *Penstemon roseus*.

6. A sixteenth-century legend recounts how Tezcatlipoca stole a mirror that produced rain, housed in Quetzalcoatl's temple (*Historia de México*; Garibay 1973, 114–15).

Tezcatlipoca's acquisition of a mirror that controls rain is in keeping with his lunar identity, for the moon seems to play a prominent role in controlling rainfall, according to ethnographic accounts in Mesoamerica (Milbrath 1999, 29).

7. Xolotl is often said to be a twin aspect of Venus, but in fact the dog god represents Mercury, which is the planetary twin of Venus, because both planets follow a similar trajectory as an inferior planet. Xolotl is the Venus twin because he represents Mercury, the only other planet that has a four-phase synodical cycle. Xolotl's descent in the Codex Borgia reflects the observed positions of Mercury in the morning sky during 1496, and the narrative actually shows two descending paths, twin trajectories of descent that pair the movements of Venus and Mercury (Milbrath 2013, fig. 4.7, sky map 5). His changing aspect in the Borgia narrative mirrors the changing phases of Mercury. Xolotl begins a short path of descent on page 37 and reaches the end when he tumbles from a platform on page 38. His brief descent encompassing a period of no more than 40 days, which is typical for Mercury in the early morning sky. The descent of Venus on pages 34–42 covers nine pages that represent an interval of 180 days. The disappearance of Venus on September 18, 1496, is depicted by the sacrifice of the Venus god on page 42 (Milbrath 2013, plate 14). Mercury's disappearance on June 18, 1496, is represented on the top of page 38 by the image of Xolotl tumbling off a platform and transforming into a skeletal god floating in the waters of the underworld during Mercury's superior conjunction phase (last visibility of Morning Star on June 18) (Milbrath 2013, table 4.2, plate 9).

8. The Atamalcualiztli ceremony took place every eight years to coordinate cycles of Venus with the Sun and Moon during Hueypachtli or Quecholli (Milbrath 2000, 2013, 30). In the Borgia narrative, Atamalcualiztli was clearly performed during Hueypachtli in the year 1496 (Milbrath 2013, 95).

9. All dates on table 6.2 are from the Julian calendar in use prior to 1582, so the winter solstice fell on December 11, 1496, during Panquetzaliztli, coinciding with Borgia 46. Even though page 46 ends the narrative, it does not bring the year to a close because the calendar year ended in February among the Tlaxcalans, as it did among the Aztecs (Milbrath 2013, table 2.3). Almost immediately following the narrative, an almanac on Codex Borgia pages 49–52 carries the year to an end in February. This four-page directional almanac records yearbearer dates spaced at 13-year intervals. The four yearbearer dates (4 House, 4 Rabbit, 4 Reed, and 4 Flint) are paired with *Tonalpohualli* dates that all bear the number five (5 Earthquake, 5 Wind, 5 Deer, 5 Grass) to form *Xiuhmolpilli* dates that fall in Izcalli, the eighteenth festival of the year, when there was a fire-drilling ceremony like that shown on each of the yearbearer pages (Milbrath 2013, 35).

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*Iconography and
Metaphorical Expressions
Pertaining to Eclipses**A Perspective from Postclassic
and Colonial Maya Manuscripts*

As Anthony Aveni (2001, 219) points out in his book *Skywatchers*, archaeoastronomical studies “are meaningless unless those who pursue such investigations take the trouble to articulate the relationship between the data they collect and theories of culture.” It is with this consideration in mind that I pursue questions of what eclipses signified for Maya cultures and why Maya astronomers and daykeepers were so assiduous in tracking their possible occurrence through the development of the eclipse table in the Dresden Codex, as well as the Lunar Series in Classic period (A.D. 200–900) monumental texts and calculations such as those recently discovered at the site of Xultun in Guatemala (Aveni et al. 2013; Saturno et al. 2012).

This study explores questions concerning the relationships between contemporary and Colonial or Postconquest period (A.D. 1519–1697) beliefs and practices associated with eclipses and those documented in Prehispanic sources such as the Maya codices and murals painted on Postclassic period (A.D. 900–1519) structures. Terminology describing eclipses from contemporary and Colonial sources suggests that they were (and still are, in some areas) seen as dangerous periods of time when the forces of chaos emerge. As such, they are like the five nameless days of Wayeb at the end of the Prehispanic Maya solar year; indeed, both Wayeb and eclipses are seen as potentially presaging the end of the world or the current era.

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This connection is made explicitly in several Colonial texts, where eclipses as periods of danger and chaos (and potentially the end of the world) are framed within the context of Wayeb (see Taube 1988, 290–92). The following passage from the *Book of Chilam Balam of Chumayel* provides an illustrative example (Roys 1933, 112): “The face of the sun shall be turned from its course, it shall be turned face down during the reign of the perishable men, the perishable rulers. Five days the sun is eclipsed, and then there shall be seen the torch of [K’atun] 13 Ahau.”

The reference to the sun being eclipsed for five days appears to be an allusion to the dark (i.e., chaotic) days of Wayeb. Furthermore, the eclipse (described as the sun being turned face down) takes place during the “reign of the perishable men, the perishable rulers.”¹ As will be seen, this could be an allusion to the previous era that is associated with the coreless people in the Books of Chilam Balam and the wooden people in the *Popol Vuh*, who are destroyed as a result of their lack of understanding. This example makes it clear that eclipses serve a particular function in the structure of Maya narratives, where they mark a period of transition from a particular time period (such as a year, a *k’atun*, or an era) to the one that succeeds it.² In this sense, they play a role in mythic time that may or may not have a connection to historical time as well. By way of example, it can be argued that the eclipse season referenced on page 74 of the Dresden Codex (figure 7.1) signifies the end of a previous era (Taube 1988:172, 174n5; Vail and Hernández 2011), but that it can also be tied to an actual eclipse that can be validated in the historical record (dated to September, A.D. 759, by H. Bricker and V. Bricker [2011, 442], and to February, A.D. 536, by Vail and Hernández [2013, 167]).

METAPHORICAL EXPRESSIONS RELATED TO ECLIPSES

In texts dating to the Postclassic period, a compound glyptic expression that includes ZQ1/T326 and either the *k’in* “Sun” glyph (XQ3/T544) or the Moon (*uh*, or ZU2/T682b) most commonly references eclipses.³ On occasion, a metaphorical expression is used instead, many that are closely related to those used by contemporary Maya people (listed below); this occurs most commonly in contexts in which the eclipse being referenced is meant in a figurative sense (to signal the end of a particular time period) rather than more literally. In addition, references to the Sun being blinded or its face covered as a means of describing an eclipse are also found in Colonial period Maya texts as well as in Postclassic iconography, where they seem to relate both to descriptions of actual eclipses but also to those that were used to signify the end of a previous era or “Sun.”



FIGURE 7.1. Dresden 74, which pictures a crocodilian in the sky, belching forth a torrent of water from its open mouth. Its body forms a skyband that includes the following glyphs: Venus, the sky, a darkened Sun, and night; below this is suspended a solar and lunar eclipse glyph, from which water pours. The two figures pictured include the creator goddess Chak Chel in her destructive aspect, overturning a jar of water, and the black deity God L in the guise of a Venus warrior (after Förstemann 1880, plate 74).

Among contemporary Maya peoples, the expressions that are used to describe an eclipse of either the sun or the moon include the following:

YUCATEC (Barrera Vásquez et al. 1980, 33, 93, 824):

bala'an u wich k'in 'hidden its face the sun'

chi'bil k'in/u 'to be bitten the sun/moon'

chi'ba k'in/u 'bitten sun/moon'

tupul u wich k'in/u 'to be extinguished its face/eye the sun/moon' (i.e., 'to blind the sun/moon')

LACANDON (Bruce 1979, 322):

xu'tan or *xulik t'an* 'the end of the world [in reference to an eclipse]⁴

CH'OL (Closs 1989, 390):

woli k'uxbahlum 'the jaguar is eating it [the Sun or the Moon]'

TZOTZIL (Laughlin and Haviland 1988, 1:186–87; reported in Ilía Nájera 1995, 322):

cha'k'ak'al [solar eclipse], *cham'u* [lunar eclipse]: refers to sickness or death of the Sun and Moon

Expressions similar to these have been previously recognized in hieroglyphic sources; in particular, an abbreviation of *pa'al k'in* (as *pa'k'in* 'broken sun' [XD₁ XQ₃]) was first identified by the Bricker in the eclipse table of the Dresden Codex (see H. Bricker and V. Bricker 2011, 328) and by the author on page 67b of the Madrid Codex (Vail 2003). This chapter explores several other examples of these expressions and documents their usage, both in reference to actual historical eclipses predicted by the Maya and to describe the mechanism (or one of the mechanisms) by which the previous world was said to be destroyed according to indigenous Yucatec and highland Maya colonial sources. The expressions that will be considered include *tupul u wich k'in* 'to be extinguished the sun's eye', *cha'k'ak'al* 'the sun's death', and *xu'tan* or *xulik t'an*, referring to the end of speech. None of these are found in this exact form in Prehispanic texts, but similar metaphors (*wa'ak yich ahaw* 'to be extruded the lord's eye', *ab kimir u k'in* 'the sun is the dead person', and *xul k'in xul haab* 'end of days [or Sun], end of years') occur on a number of separate occasions in Postclassic sources, where they are found in both the barkpaper screenfold books, or codices, and murals painted on the interior and exterior of structures.

These expressions are reminiscent of events surrounding the destruction of the previous race of beings, described as the wooden people in the *Popol Vuh*

(Christenson 2007) and the “coreless” people in the Books of Chilam Balam of Chumayel, Tizimín, and Pérez (Knowlton 2010, 62, 65). The *Popol Vuh*, believed to have been written in the mid-sixteenth century by three members of the K’iche’ ruling lineage, describes the attempts of the gods to create beings capable of worshiping and sustaining them (Christenson 2007, 35–37),⁵ whereas the Books of Chilam Balam include a mixture of indigenous texts that appear to have Prehispanic antecedents, as well as European texts compiled (and often modified) by Yucatec Maya scribes beginning in the late seventeenth century (Bricker and Miram 2002, xvi–xvii, 8; Knowlton 2010, 40–42).

ACCOUNTS OF PREVIOUS SUNS OR ERAS

According to the *Popol Vuh*, before the creation of the present race of people, the creator gods made several attempts to form beings that were capable of understanding. One of these involved the creation of the wooden people, who are described as “merely an experiment, an attempt at people . . . who had no blood or blood flow” (Christenson 2007, 83–84). Nevertheless, they continued to multiply, and a being called Seven Macaw set himself up as their lord. He describes himself as follows: “I am great. I dwell above the people who have been framed and shaped. I am their sun. I am also their light. I am also their moon” (Christenson 2007, 92). He is not the true Sun (i.e., that associated with the present era) but may instead be described as the “false Sun,” who presided as the Sun of a previous era. It is of interest that the contemporary Lacandon Maya use a similar expression (*ah säh k'in* ‘false Sun’) to describe Venus in its Morning Star aspect (Milbrath 1999, 34). This suggests a connection between this former Sun and Venus, much as may be seen in Central Mexican accounts from the *Leyenda de los soles* in which the Sun of the second era, Quetzalcoatl, plays a role in Mexican mythology as the Morning Star aspect of Venus (Bierhorst 1992, 36–37).

The description of Seven Macaw continues as follows: “Now Seven Macaw was not truly the sun, but he puffed himself up in this way because of his plumage and his gold and silver . . . He desired only greatness and transcendence before the light of the sun and the moon were revealed in their clarity. This was in the era when the flood was made because of the effigies of carved wood” (Christenson 2007, 93).⁶

Because of his arrogance, the creator Heart of Sky decrees that Seven Macaw must be overthrown. This is accomplished by removing the gemstones that form his teeth and “plucking” his eyes (i.e., removing the precious metal from them). As a result, he simply stared: “Thus the wealth of Seven Macaw

was lost, for the healers took it away—the jewels, the precious stones, and all that had made him proud here upon the face of the earth” (Christenson 2007, 100). The plucking of his eyes calls to mind the acts of blindfolding and blinding that are described in relation to *k’atun* 11 Ahaw in the Books of Chilam Balam (see appendix 7.1). If it can be related to the former, it provides an especially close fit with the blindfolding of the Venus deities seen in the Books of Chilam Balam and colonial highland Mexican sources, as well as in both Maya and Mexican codices (see discussion below).

The defeat of Seven Macaw is linked to the destruction of the “framed and shaped people,” or effigies carved of wood, those then inhabiting the earth (Christenson 2007, 90). Their defeat came in many forms—through a flood or great rain of resin from the sky, an attack by jaguars, and an attack by their domesticated animals and utensils. In reference to their destruction by the jaguars, it is of interest that they had their eyes gouged out and their heads cut off (Christenson 2007, 85). In the *Popol Vuh* and in Maya culture more generally, seeing is linked to understanding. In a later episode in which the present race of humans is created, their sight is considered too perfect and so must be dimmed by the gods so that they do not have divine powers: “They were blinded like breath upon the face of a mirror. Thus their eyes were blinded . . . Thus their knowledge was lost” (Christenson 2007, 201).

An episode recorded in the Books of Chilam Balam of Chumayel, Tizimín, and Maní has a number of parallels with the Seven Macaw narrative. It involves the deities Bolon Ti Kuh [Bolon Ti’K’uh] ‘Nine as God’ and Oxlahun Ti Kuh [Oxlahun Ti’ K’uh] ‘Thirteen as God’, who can be identified as underworld and Venus deities (the Bolon Ti’ K’uh) and celestial deities (the Oxlahun Ti’ K’uh).⁷ Specifically, page 14v from the *Book of Chilam Balam of Tizimín* states that the Oxlahun Ti’ K’uh “dawned” because of the Bolon Ti’ K’uh (Knowlton 2010, 73; see appendix 7.1). A passage from the *Popol Vuh* makes it clear that Venus’s heliacal rise announced the Sun’s first appearance (“its dawning”; see Christenson 2007, 228), suggesting that the Oxlahun Ti’ K’uh may be identified in the Tizimín passage with the Sun and the Bolon Ti’ K’uh with Venus (Vail and Hernández 2013, 449). Other important figures in the Chilam Balam cosmogony include the Ah Muzencab [Ah Musen Kab] and the crocodilian Itzam Cab Ain [Itzam Kab Ayin], whose body is said to form the earth (see appendix 7.1). In the Chilam Balam narrative, the Bolon Ti’ K’uh and Oxlahun Ti’ K’uh vie for power, with first one and then the other emerging victorious.

Following the creation of the earth from the body of Itzam Kab Ayin by the Bolon Ti’ K’uh (see appendix 7.1), the Ah Musen Kab are said to emerge from the earth, only to be blindfolded by the Oxlahun Ti’ K’uh:

On the Petén
During the *k'atun* Eleven Ahaw
When the Ah Musen Kab emerged
Oxlahun Ti' K'uh blindfolds them . . .
So when it finished dawning
They knew not that it would come to pass
That Oxlahun Ti' K'uh was caught by Bolon Ti' K'uh.

(CHUMAYEL 42, TRANSLATED BY KNOWLTON 2010, 55–56)

In addition to having similarities with the episode concerning Seven Macaw in the *Popol Vuh*, this passage also calls to mind a narrative related in the Códice Chimalpopoca in which, as a consequence of aiming his arrows at the Sun, the Morning Star aspect of Venus (named Tlahuizcalpantecuhtli) was shot by the Sun's dart and thereafter transformed into the god of cold and punishment (Bierhorst 1992, 148), who may be identified by the blindfold that he wears across his eyes (Taube 1992, 110). The Chumayel passage may also refer more literally to the fact that the sun's light would cause any other nearby celestial beings to be hidden from sight.

On the basis of these similarities, an important consideration involves determining if the Ah Musen Kab deities have Venus associations. Previous scholars have identified the Ah Musen Kab as bee gods (Knowlton 2010, 56; Roys 1933, 64), based on data from colonial and ethnographic sources.⁸ In the passage from the Chumayel, they are described as having emerged (presumably from the earth) prior to the dawning (i.e., the dawning of the Oxlahun Ti' K'uh, representing the Sun). The etymology of the Ah Musen Kab epithet directly supports the identity of this being as a Venus deity or underworld lord: in colonial sources *ah* means 'he who', *mus* 'to issue forth', and *kab* refers to the earth (Bolles 2001). Ethnographic, iconographic, and epigraphic evidence all strongly support the idea that the Venus deities were underworld gods who were perceived to be the "lord" of this particular realm (Closs 1989; Thompson 1930).

Additional evidence suggesting that the Ah Musen Kab have associations with Venus comes from several scenes in the Maya codices in which Venus deities are represented wearing blindfolds. The best known of these is the figure pictured on page 50 of the Venus table, who represents the highland Mexican deity Tezcatlipoca-Ixquimilli (Smoking Mirror–Eye Bundle), or Itzlacoliuhqui-Ixquimilli (see Taube 1992, 110; Taube and Bade 1991). The name recorded for this deity in the hieroglyphic caption of the Dresden scene is Kakatunal, which may correspond to *ka* 'two', *acatl* [*akat*] 'reed', and *tonal* 'spirit-familiar, or soul'

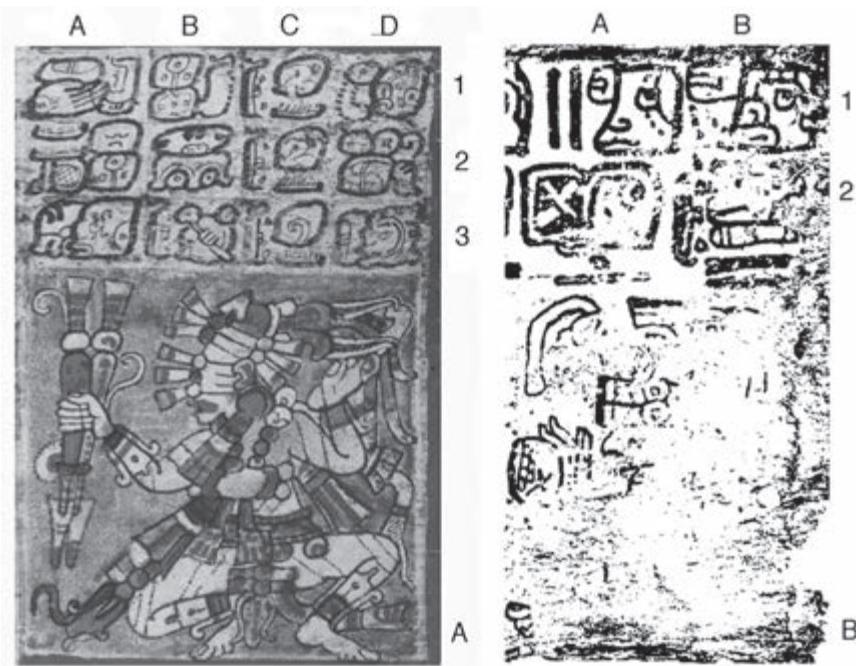


FIGURE 7.2. (a) *Ka Akat Tonal* on Dresden 5ob, named at A2 (after Förstemann 1880, plate 50); (b) *Kisin* on Madrid 6oc, named at A1 (after de Rosny 1883, plate 26).

(Vail, forthcoming [a]).⁹ Acatl (Reed) is the thirteenth day in the highland Mexican calendar, of which Tezcatlipoca-Ixquimilli is patron. Moreover, Reed is described as the year when Tezcatlipoca “smoked the skies once more,” following his initial drilling of fire in primordial time (Bierhorst 1992, 145), and it is associated with the Aztec New Fire ceremony, which was undertaken every fifty-two years in a 2 Reed year (Miller and Taube 1993, 87).

Kakatunal [Ka Akat Tonal] is pictured with knotted bands across his eyes in the scene in the Dresden Venus table, a trait he shares on occasion with the related Maya deity Kisin (figure 7.2a, b; Taube 1992, 110). Another deity, a black-painted figure who bears the accoutrements seen with the yearbearer Mams in the Dresden Codex, wears a blindfold across his eyes in the almanac on Madrid 89d–90d (figure 7.3). It is of interest that the intervals associated with five of the almanac’s frames are eights, suggesting both the number of days associated with Venus’s period of invisibility before heliacal rise in the Dresden Venus table, and also the number of solar years required for Venus



FIGURE 7.3. Blindfolded Mam, pictured in the second frame of Madrid 89d–90d (after Brasseur de Bourbourg 1869–1870, plates 23–24). Note that Kisín's glyph appears at B₂, D₂, F₂, H₂, J₂, and N₂; it is missing its eye in the first four instances.

to complete its synodic cycle.¹⁰ The presence of Kisín's glyph without a visible eye in the first four frames of the almanac (including that showing the blindfolded figure) is also worth noting. Whether this was done intentionally by the scribe remains unclear, but it does have interesting implications in light of

the connections between Kisín, the blindfolded Venus god on Dresden 50, and the blindfolding of the Ah Muṣen Kab described previously.

Returning to the text from the *Book of Chilam Balam of Chumayel*, the section following the blindfolding of the Ah Muṣen Kab refers to the capture and subjugation of the Oxlahun Ti' K'uh by the Bolon Ti' K'uh. This is expressed as follows:

When stone and wood descended
When his stick and stone came
Then Oxlahun Ti' K'uh was caught
And then his head was wounded
Then they put out his eyes ... (Chumayel 42, translated by Knowlton 2010, 57)

The references to “stone and wood” and “stick and stone” are likely metaphors for punishment, as suggested by a comparison with the Nahuatl expression *tetl-cuahuitl* (literally ‘wood and stone’), which is semantic pairing used to refer to ‘punishment’ (Miller and Taube 1993, 100). In highland Mexican sources, punishment was connected explicitly with the deity Itzlacoliuhqui-Ixquimilli, the counterpart of the Maya deity Kisín. Both the Maya and Mexican variants of this deity have explicit connections with the underworld and occasionally with Venus (see Milbrath 2013, 65, in regard to Itzlacoliuhqui-Ixquimilli, who merges at times with Tezcatlipoca), suggesting that the passage from the Chumayel relates to the punishment of the Oxlahun Ti' K'uh by the Bolon Ti' K'uh. This was presumably done in revenge for the Oxlahun Ti' K'uh's ill treatment of the Ah Muṣen Kab, who were caught and blindfolded.¹¹ The punishment of the Oxlahun Ti' K'uh, however, represents an escalation; rather than being blindfolded, they are instead blinded.

It has previously been suggested that the putting out of Oxlahun Ti' K'uh's eyes refers to a solar eclipse, comparable to the expression *tupul u wič k'in*, used among the Yucatec Maya to describe what occurs when the sun is eclipsed (Vail and Hernández 2013, 451). If this is what is being referenced, it is clear that the eclipse is attributed to the Venus/underworld deities, who are responsible for the act of blinding the Oxlahun Ti' K'uh. This fits well with data from highland Mexico (see Milbrath 2013), as well as ethnohistoric and ethnographic accounts that describe a solar eclipse as resulting from an attack by mythological beings called Xibal or Xulab (López de Cogolludo 1971, 1:239; Sánchez de Aguilar 1953, 121–22). The former appears to be a reference to the underworld (Xibalba in K'iche'), which is home to Venus when it resides in the underworld (during its period of invisibility when it is in conjunction with the sun), whereas Xulab among the Yucatec Maya refers to Venus as the cause of eclipses (Milbrath

1999:26) and is also the name of Venus as Morning Star among the contemporary Q'eqchi' and Mopan Maya (Thompson 1970, 250).¹²

The Chumayel passage concludes with a reference to *u hol sabak* (see appendix 7.1). The latter can be interpreted as ‘his sooty head’, which may be an epithet for the rain god, whose name is Mensabák (‘Maker of Soot’) among the Lacandón. Alternatively, it calls to mind a description from the Florentine Codex in which the eclipsed Moon is described as “covered with soot” (Sahagún 1950–1982, VII:8, plate 4, in Milbrath 1997). In this case, however, the author of the Chumayel narrative may have used the phrase as a means of referring to an eclipse of the sun (i.e., “the sun’s head is sooty”).

The blinding of the Sun is not explicitly shown in the Maya codices, but there are several scenes that may refer to battles between Venus and the Sun. On page 47 of the Dresden Venus table, for example, a jaguar named Chak Balam (pictured in the lower register) has been speared by a Venus deity called Lahun Chan, who is pictured with his spear-thrower and darts in the middle register of the page (figure 7.4). The jaguar has been interpreted as an aspect of the Sun (Miller and Taube 1993, 104; Taube 1992, 54; but see Milbrath 1999, 124), which receives support from its role on page 26 of the Dresden yearbearer pages (see Vail 2000) and by the hieroglyphic caption to the register picturing Lahun Chan, which includes the statement *yah? na’ak*, ‘Woe to the rising [sun]’ (rS5 HT2, or T17.227b). Based on this evidence, the scene on Dresden 47 appears to refer to a battle between the celestial and underworld deities similar to that described in the Books of Chilam Balam. Following the spearing of the jaguar Sun, the caption to the picture of the speared jaguar in the lower register of Dresden 47 states that Ka Akat Tonal “is buried.”¹³ This recalls an episode recounted in both Nahuatl and Maya (Lacandón) mythology in which the creator deity, after being resurrected, returns to claim his triumph over the Venus/underworld lords by causing them to tumble into the underworld, where they are bound and imprisoned (Bierhorst 1992, 149; Cline 1944; Thompson 1970, 344–45).¹⁴

Murals recorded from Mound 1 at Santa Rita in present-day Belize by Thomas Gann’s expedition to the site at the end of the nineteenth century are also of interest in relation to the discussion of Venus as an eclipse agent associated with blinding or extinguishing the Sun (figure 7.5). On the west half of the north wall of Mound 1, the Maya creator deity Itzamna is pictured holding a serpent scepter and wearing a headdress in the form of a quetzal, attributes that previous scholars have suggested serve to link him to Quetzalcoatl or K’uk’ulkan (Gann 1900, 668; Taube et al. 2010, 171). He stands within the entwined bodies of two feathered serpents that have been associated with the wind or Venus aspect of this deity (Taube et al. 2010, 171).



FIGURE 7.4. Dresden 47b–c, featuring the Venus deity Lahun Chan spearing a jaguar in the register below (after Förstemann 1880, plate 47). Lahun Chan is named as the “great star” or Venus at A2 in the caption and Chak Balam as his victim at A3.

This figure appears with a glyptic caption that begins with the date [*K'atun*] 11 Ahaw, followed by a collocation that reads Wak (six) Yich Ahaw.¹⁵ Yich Ahaw refers to ‘the lord’s face’ or ‘the lord’s eye’. The prefix *wak* was probably not intended to refer to the number six in this instance, but rather to the deity who personifies this number (figure 7.6). Reference to the head variant form reveals that the distinguishing feature of this deity is an axe (*2M7/T190*) in the region of the eye. This grapheme has been read as *wak*

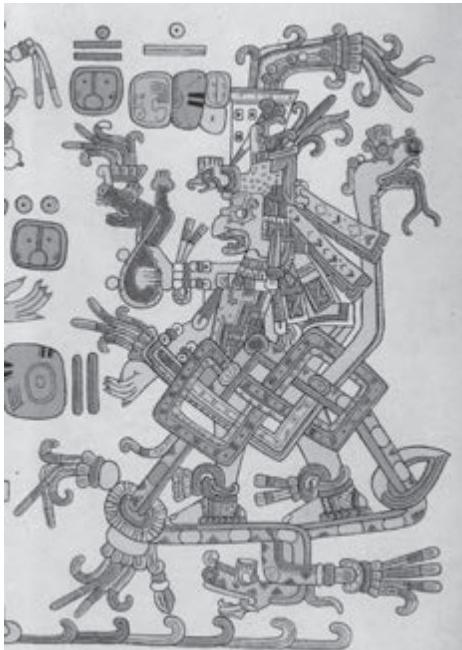


FIGURE 7.5. *Wak Yich Ahaw* epithet associated with Itzamna, west half of North Wall, Mound 1, Santa Rita (after Gann 1900, plate 30). It consists of the glyptic collection adjacent to Itzamna's headdress.

'to extrude' (V. Bricker and H. Bricker 1986) or *ch'ak* 'to cut, chop, decapitate' (Orejel 1990) or 'to cause harm' (H. Bricker and V. Bricker 2011, 384). The caption as a whole, then, can be interpreted as "The eye of the [Sun] lord is extruded [or harmed or cut out] in K'atun 11 Ahaw." Alternatively, if this phrase serves as an epithet, it may refer to Venus as the one who damages the Sun god's eye(s). This description corresponds closely with the manner in which the Venus gods (the Bolon Ti' K'uh) are described in the Chilam Balam accounts referenced previously.

The date associated with the Santa Rita mural scene (11 Ahaw) is also of interest. If it refers to a *k'atun*, as seems likely, it may be describing the same *k'atun* 11 Ahaw as that in the *Chilam Balam of Chumayel*, in which the Sun god's (or Oxlahun Ti' K'uh's) eye is put out (see appendix 7.1). This follows the episode dated to the previous *k'atun* (13 Ahaw) in which Itzam Kab Ayin ascended to the sky to bring forth a flood but was forestalled by the Bolon Ti' K'uh, who cut the crocodilian's throat and created the earth from his body (see appendix 7.1). The blinding of Oxlahun Ti' K'uh may signify an eclipse, which is followed by a flood that resulted in the destruction of the coreless people (Chumayel 43, lines 14–18; see Knowlton 2010, 62, 65).



FIGURE 7.6. Head variant of the number 6 (after Morley 1915, fig. 51).

An epithet from the Colonial period Yucatec text known as the Ritual of the Bacabs has a meaning similar to Wak Yich Ahaw; it is written as Kolop U Wich K'in, Kolop U Wich Ak'ab 'Snatcher of the Eye of the Day, Snatcher of the Eye of the Night' (Roys 1965, xix). Michael Closs (1989, 399–400) has identified this as the name of an eclipse agent and a Venus deity. Similarly, Milbrath (1999, 24, 34, 205) notes that Venus is called Nohoch Ich 'Big Eye' among the contemporary Q'eqchi' and Mopan Maya (Thompson 1930, 60–63, 120–25).

The Wak Yich Ahaw epithet (006 1 ZUH MR7, or TVI.168.17.671) occurs seven times in the Maya codices: once in the Madrid Codex (on Madrid 42c), three times in the Paris Codex (on Paris 4c, 9b, and 10b), and three times in the Dresden Codex (twice on Dresden 48 and once on Dresden 34c).¹⁶ Two of these examples occur on page 48 in the Dresden Venus table; in one, the deity is said to "arm" Venus (associated with the 13 Mak version of the table dated to A.D. 1123 by H. Bricker and V. Bricker 2011, 187), and in the other, Wak Yich Ahaw is named as the deity who feeds or sustains Venus (associated with the 18 K'ayab version dated to A.D. 934 by H. Bricker and V. Bricker 2011, 187). In both instances, the text characterizes Venus (Chak Ek', or 'Great Star') and Wak Yich Ahaw as being in the west.

Another example of the Wak Yich Ahaw epithet occurs in the second frame of the almanac on pages 33c–39c of the Dresden Codex (figure 7.7). The text caption reads:

A

B



FIGURE 7.7. *Wak Yich Ahaw* epithet at B1 of Dresden 34c (after Förstemann 1880, plate 34).

T₁.T667.T₁₃₀ TVI.T₁₆₈.T₁₇.T₆₇₁ T668.T₁₀₂ T₇[501]
HE6 MZQ₂S₂ oo6 ZUH MR₇ MZ₉ tB₂ ZV₇
u-an?-wa wak yich ahaw chaak ?? ha'
to be [in a place]¹⁷ Wak Yich Ahaw Chaak ?? water

Below the caption is a picture that shows Chaak seated on a *ka'an* 'sky' glyph, holding his axe aloft. Attached to the front of the *ka'an* logograph is a portrait glyph with what appears to be a detached eyeball and optic nerve, suggesting that the lord with the extruded eye and Chaak are both in the sky. What remains less clear is whether Chaak is intended to represent the eclipse agent in this particular instance.

This visual depiction of the lord's eye (presumably that of the Sun) torn from its socket raises the question of whether this was meant to refer to an actual solar eclipse, or whether it had a more metaphorical meaning. An argument in favor of the former interpretation may be found by examining the final collocation in the text caption on Dresden 34c, which depicts the glyph for water (*ha'*) within a vessel (B₂ in figure 7.7). If it has a meaning related to what is portrayed (water within a bowl), it may be analogous to a practice documented among the contemporary Lacandón and K'iche' Maya, who watch reflections of eclipses in containers of water (B. Tedlock 1992, 184).

The Brickers have dated this particular almanac to the early sixteenth century (H. Bricker and V. Bricker 2011, 673). According to the dating model they propose, the frame in question is not associated with an eclipse. The Brickers relate the picture of Chaak seated on a sky glyph to the winter solstice, specifically that occurring on December 22, 1514. Although not dating to the same year, it is interesting to note an association between eclipses and days bracketing the winter solstice throughout the fifteenth and early part of the sixteenth century (i.e., December 21, 1413; December 20, 1433; December 20, 1452; December 20, 1471; December 22, 1479; December 22, 1498; and December 23, 1517). The astronomer-scribe who drafted this almanac may have been aware of this association and may have chosen to portray it graphically, even though an eclipse was not predicted on the particular winter solstice targeted by the frame. Alternatively, it is possible that what appears to be a reference to an eclipse in the picture represents an artifact from a previous version of the almanac (when a solar eclipse did occur on the winter solstice) that was not eliminated when the almanac was subsequently updated.

The central panel on Dresden 3a (figure 7.8), which depicts a sacrificial victim atop an altar formed by the bodies of two serpents with their heads at its base, may also be a reference to an eclipse. In this respect, it is of interest that



FIGURE 7.8. *Sacrificial scene on Dresden 3a (after Förstemann 1880, plate 3).*

a tree grows from the victim's open chest, on top of which a vulture perches; additionally, the vulture may be seen to have plucked out the eye of the sacrificial victim.¹⁸ Among the contemporary Tzotzil Maya, eclipses are times of danger when birds of prey descend to snatch out the eye of a human victim (Ilía Nájera 1995), much as is depicted in this scene. The association of birds with trees is common in both Prehispanic depictions (dating from the Preclassic [2000 B.C.–A.D. 200] through Postclassic periods) and in Colonial period texts, such as that described in the *Chilam Balam of Chumayel*, in which the world trees are set in place, each with an associated color-directional bird (Knowlton 2010, 65; Roys 1933, 100).

The vulture in the Dresden scene may be a Postclassic Yucatec variant of Seven Macaw, who is portrayed here in his ascendancy before his defeat by the Hero Twins and the creator deities. The victim on Dresden 3a remains unidentified, but the hieroglyphic caption refers to 'dead person,' 'end of ?', and 'his evil omen' (at D₁ and C₂–D₂),¹⁹ which serves to further support the interpretation of the scene as portraying an eclipse (see the discussion of the expression *xul t'an* below). It is also of interest that the day glyphs that begin the almanac (1 Ahaw, 1 Eb, 1 K'an, 1 Kib, and 1 Lamat) are the same as those

that represent the heliacal rise dates of Venus in the Dresden Venus table (Vail and Hernández 2013, 318–20).

An expression used in reference to eclipses by the contemporary Lacandon Maya is *xul t'an* 'end of speech' or, more broadly, 'end of the world' (Bruce 1979, 322). The Lacandon believe that the destruction of the current world is predicted to result from—or be signaled by—an eclipse and that eclipses presaged the ending of the previous ages or creations (Bruce 1979, 322). Las Casas ([ca. 1550]1967, III.CCXXXV.507, in Christenson 2007, 85–86n123) calls attention to a similar belief dating to the early Colonial period, noting that "[T]hey believe that another Butic [flood of many waters, or 'judgment'] is about to come, which is another flood and judgment, not of water, but of fire, which they say would be the end of the world . . . and the moon and sun would be eclipsed, saying that they would be eaten."

I propose that an expression found in the Maya codices (3MB XQ3 3MB XH₂, or T267:544 T267:548), with a suggested reading of *xul k'in xul haab* 'end of days, end of years' (Schele and Grube 1997, 82)—but signifying more broadly 'end of time'—may be identified as referring to the destruction of the previous "race" of beings, the wooden (or coreless) people described in the Colonial period *Popol Vuh* and Books of Chilam Balam. It is found, for example, in the preface to the Venus table, where it occurs in the following passage (figure 7.9a):

u mu'uk kab

The earth is buried.

u mu'uk u ch'een

The cave is buried (i.e., the earth-cave is buried);

u mu'uk winik

The people are buried.

xul? k'in

End of? days [or the Sun],

xul? haab

End of? years.

A similar passage from the *Book of Chilam Balam of Chumayel* refers to the destruction of the "coreless" people in the following terms:

That's how they lived without their hearts

And so were submerged

By waves of sand

And waves of sea (Chumayel 43, translated by Knowlton 2010, 61)

There appears to be a close semantic relationship between the “burial” of the earth-cave and the people in the Dresden passage and the “submerging” of the coreless people in the Chumayel narrative. The parallels between the two suggest that they both refer to the end of that particular creation or world age, an idea that is reinforced by the *xul? k'in xul? haab* reference in the Dresden passage.²⁰

On page 37 of the Madrid Codex (figure 7.10), the death and burial of the Sun (*u mu'uk k'in ab kimir*)—expressions found elsewhere in the codices in reference to eclipses (H. Bricker and V. Bricker 2011, 305–15)—is followed by the phrase *xul? haabil xul? k'in*.²¹ Together, the whole would read “The sun is buried; he is the dead person. The end of years [time], the end of the sun.” This occurs on the yearbearer page referencing *Ix* years in the Madrid Codex, years that are described as having particularly dire prognostications (Tozzer 1941, 146–47). Moreover, it is significant that this passage is associated with a picture showing the beating of drums and a dog howling (in the upper register of page 37; figure 7.10), since both means of producing noise are mentioned in colonial and contemporary accounts as ways of scaring away the creature causing an eclipse (Closs 1989, 391–92). For example, Sánchez de Aguilar (1921, 302), in a report written in 1639, notes that “During lunar eclipses, they still believe in the tradition of their forefathers to make their dogs howl or cry by pinching them either in the body or ears, or else they will beat on boards, benches, and doors. They say that the moon is dying, or that it is being bitten by a certain kind of ant which they call *xubab* [*sic*].”

In the 1930s, the Yucatec Maya continued to follow similar practices. Villa Rojas (1945, 140b, 156a–157a) notes that, among Maya communities in Quintana Roo:

Eclipses are greatly feared because it is believed that a total eclipse of the sun or moon would cause all the domestic implements then to be transformed into living creatures and kill their masters, revenging themselves for the bad treatment they have suffered . . . To drive away the enemy attacking the sun or moon, it is customary to fire off guns in the directions of the threatened luminary but no other noises are made, such as beating drums, as noted in other Maya regions. When an eclipse occurs, pregnant women are required to keep indoors so that their children may not be born with spots on their faces or bodies.

This description calls to mind the section of the *Popol Vuh* in which the domestic animals, grinding stones, and other implements used by the wooden people revolted against their masters, leading to the undoing of the framed and shaped people (Christenson 2007, 89). This occurred when the creator, Heart of Sky or

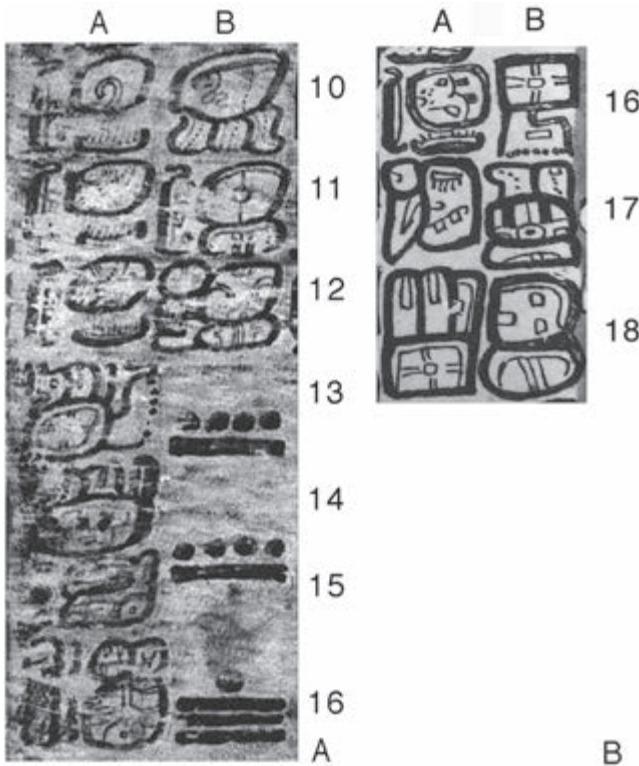


FIGURE 7.9. (a) Hieroglyphic text from preface to Venus table (after Förstemann 1880, plate 24); (b) hieroglyphic text from Madrid 37, referring to the Ix yearbearer ceremonies (after Brasseur de Bourbourg 1869–1870, plate 20).

Huracan, caused the face of the earth to be darkened (Christenson 2007, 87), a description that may refer to the darkening that accompanies a solar eclipse.²² As described by an eyewitness, “Night slowly descend[s]. With the intervening darkness, the humid air is suddenly cooled … Animals scurry confusedly about the landscape, and birds scatter in flocks overhead” (Aveni 2002, 75–76).

On occasion, the *xul? k'in xul? haab* expression occurs in conjunction with a collocation that reads *k'in ak'ab-ih* ‘the sun [or day] darkens’ (XQ₃ XH₉ 33F, or T_{544.504:136}). The fact that the latter expression co-occurs with eclipse glyphs on a number of occasions in the Dresden Codex (see, e.g., frame 2 on Dresden 37c, frame 2 on Dresden 41b, and frame 2 on Dresden 66a) suggests that it may refer to the darkening of the day (and sun) that occurs during a solar eclipse. The caption to the second frame on Dresden 66a, for example,



FIGURE 7.10. Madrid 37, featuring a scene in the upper register that can be interpreted as referring to an eclipse (after Brasseur de Bourbourg 1869–1870, plate 20).

begins with paired solar and lunar eclipse glyphs, referring to an eclipse season (figure 7.11a). This is followed by a reference to Chaak, who is pictured in the scene below. Next comes the *k'in-ak'ab* expression ‘the day [or sun] darkens’. The same pattern of events is also suggested by the glyphs occurring in the skyband in the accompanying picture: the darkened Sun (*k'in*) glyph followed by *ka'an ak'ab* ‘the sky in darkness’. The Brickers note that this frame could have been used for targeting eclipse seasons during the fifth through seventh multiples of the table, beginning in October of A.D. 951 (H. Bricker and V. Bricker 2011, 530).

Likewise, a solar eclipse possibly dated to June 28, A.D. 1517 (H. Bricker and V. Bricker 2011, 672), seen in the second frame of Dresden 37c (figure 7.11b),

is associated with the *k'in ak'ab-ib* expression appearing in the text caption and with an *ak'ab* and darkened *k'in* glyph in the skyband associated with the picture. Here Chaak is portrayed with the weapons of a Venus warrior (a shield and atlatl), suggesting that he may be playing the role of an eclipse agent (likely Venus) in this instance (see Milbrath 1999, 201–4, and Vail and Hernández 2013, 299–302, 304, for other examples of Chaak as an aspect of Venus). Other eclipse agents portrayed in the Maya codices are discussed in Closs's (1989) detailed exposition on the topic.

SOLAR ECLIPSES AND WORLD DESTRUCTION: DISCUSSION AND CONCLUDING THOUGHTS

Among the Colonial and contemporary Maya, eclipses are associated with times of considerable danger, leading to the blinding or disfigurement of an individual, harm to a pregnant woman or her unborn child, mauling by descending celestial beings, death, and possibly the destruction of the world (Closs 1989; Ilía Nájera 1995). The survey presented above suggests that many of these ideas are Prehispanic in origin. In addition to the examples previously discussed, the yearbearer pages of the Paris Codex show the descent of jaguars (figure 7.12), likely a reference to the end of a particular “Sun” or era that may be associated not only with eclipses but also with the Wayeb period (compare, e.g., the destruction of the wooden people in the *Popol Vuh*). Other connections between eclipses and the Wayeb period may be seen in the Chumayel text cited at the beginning of the chapter and page 74 of the lower water table found in the Dresden Codex (see figure 8.1), which references an eclipse season in connection with a deluge of water, followed by the re-creation of the world on the Dresden yearbearer pages (Taube 1988, 219–20).

The identification of iconography and several different glyptic expressions representative of eclipses in Postclassic Maya texts allows the possibility of expanding our understanding of how these events were perceived by Yucatec Maya speakers on the eve of the conquest. That they were linked to times of danger comes as no surprise, given ethnohistoric and ethnographic accounts that allude to eclipse “monsters” and the destruction of the Sun or the Moon (Closs 1989; Ilía Nájera 1995). That these times of danger coincided with periods of transition marking the end of particular intervals of time (the *haab* and the *k'atun*, as well as much longer periods) is made explicit in both the Prehispanic codices and Colonial period texts such as the Books of Chilam Balam. In these instances, it was not the eclipses that were predicted so precisely by tables like that on pages 51–58 of the Dresden Codex that were of

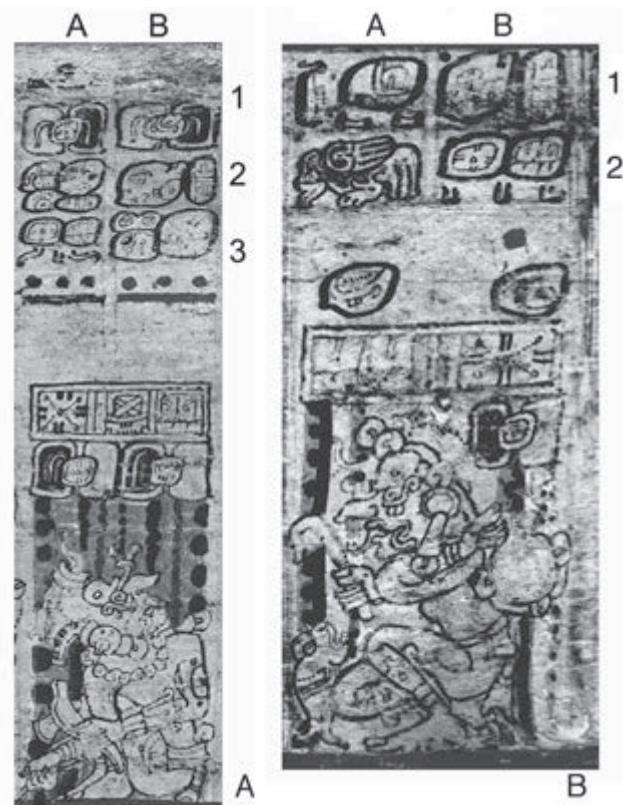


FIGURE 7.II. (a) Frame 2 on Dresden 66a, with eclipse references at A1–B1 in the hieroglyphic caption as well as in the figure; (b) solar eclipse on Dresden 37c, referenced both in the picture and likely by the glyptic collocation at B2 in the caption (after Förstemann 1880, plate 66).

concern, but rather those associated with liminal periods ruled by the forces of chaos. Unless these forces could be defeated (i.e., unless the solar deities/Oxlahun Ti' K'uh were able to triumph over the underworld/Venus deities, the Bolon Ti' K'uh), the Sun would be overcome and a period of darkness would ensue (Closs 1989). Both Colonial texts and the Maya codices suggest that earlier eras that existed prior to the current one, and the beings that inhabited them, were destroyed in just this way.

Eclipses were a source of fear to the Prehispanic Maya precisely because it was believed they could portend a similar end for the present creation of humans, the people of maize who conceptualized and wrote the Maya codices. It is for this reason that they are given prominence in Postclassic and Colonial period texts—both actual eclipses that were predicted to occur during the period when the manuscripts were in use, but also references to eclipses that took place in primordial times and presaged the end of a previous Sun or era.

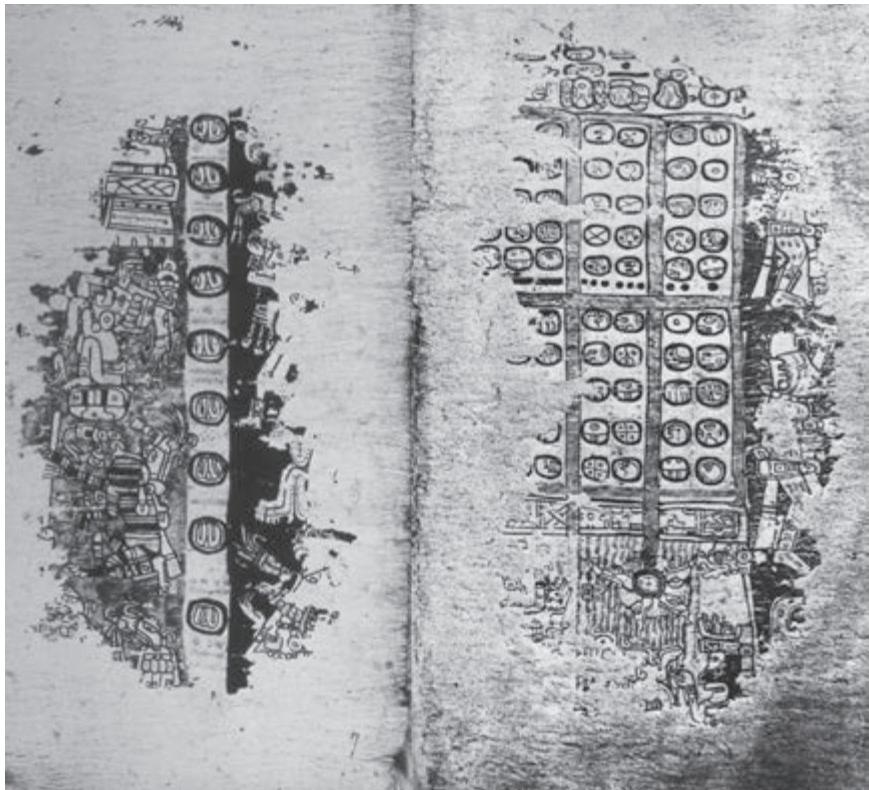


FIGURE 7.12. Paris 20–21, showing a possible eclipse (bottom of page 21) and the descent of jaguars (top of rightmost side of page 20) in relation to the yearbearer ceremonies (after de Rosny 1888, plates 20–21).

Despite these fears, triumph over the forces of darkness is witnessed again and again in the ceremonies of renovation and world renewal that are highlighted in the almanacs and astronomical tables of the screenfold books.

APPENDIX 7.1

K'ATUN 13 AHAW FROM THE *CHILAM BALAM OF TIZIMÍN*

Ca tali uy abal cab ti oxlahun ku tumen bolon ti ku

Then the dawn of Oxlahun K'uh came because of Bolon Ti' K'uh²³

Ti ca sibi ch'abi

When he was born, engendered.

Ca sibi Ytzam Cab Ain

Then Itzam Kab Ayin was born

Xoteb u kin balcah

That he may signal the day for the whole world.

Ca haulahi caan

Then the sky was turned face up

Ca nocpahi peten

Then the land was turned face down

Ca ix hop'i u hum oxlahun ti ku

And then Oxlahun Ti' K'uh's din began.

Ca uchi noh haicabil

Then the great destruction of the world arrived.²⁴

Ca liki noh Ytzam Cab Ain

Then great Itzam Kab Ayin ascended

Dzocebal u than u uudz katun lai hun ye ciil

That this deluge may complete the word of the *k'atun* series,²⁵

Bin dzocecebal u than katun

That the word of the *k'atun* might be complete.

Ma ix y oltah bolon ti ku i

But Bolon Ti' K'uh did not desire it

Ca ix xoti u cal Ytzam Cab Ain

And then Itzam Kab Ayin's throat was cut.²⁶

Ca u ch'aah u petenil u pach

So he sprinkled the island, its back

Lai ah uoh puc u kabae

This is its name: Calligrapher Hill.²⁷

Ma ix u toh pultah u kaba tiob

Neither did he really confess to them its name.

Ti kaxan tun u uich ualac y abaulil lae

He had bound the eyes then of this current reign.²⁸

(TIZIMÍN MANUSCRIPT 14V.16–25; TRANSLATED
BY KNOWLTON 2010, 73)

K'ATUN II AHAW FROM THE CHILAM BALAM OF CHUMAYEL

Ti peten

On the Peten

Ychil buluc ahau

During the *k'atun* Eleven Ahau

Tij ca hoki ah mu[s]en cab

When the Ah Musen Cab emerged

Kaxic u uichob oxlahun ti ku

Oxlahun Ti Ku blindfolds them.

Ma yx y oheltahobi v kaba halili v cic y v mehenobe

Neither his older sister nor his children knew his name any longer.

Y alahob t i

They spoke to him

Ma ix chacanhij v uich ti ob xan

But his face was not revealed to them either.

Tuchi yx ca dzoci vy abalcabe

So when it finished dawning

Ma yx y oheltahob binil vlebal

They knew not that it would come to pass,

Ca ix chuci oxlahun ti ku tumenel bolon ti Ku

That Oxlahun ti Ku was caught by Bolon Ti Ku.

Ca emi kak

When fire descended

Ca emi tab

When tumplines descended²⁹

Ca emi tunich y che

When stone and wood descended

Ca tali v baxal che y tunich

When his stick and stone came

Ca ix chuci oxlahun ti ku

Then Oxlahun Ti Ku was caught

y ca ix paxi u pol

And then his head was wounded.

Ca ix lahib v uich

Then they put out his eyes.

Ca ix tubabi

Then he was spat upon.

Ca ix cuchpachhi xan

Then he was knocked down flat, too

Ca ix colabi v cangel y v holsabac

Then his archangel was tugged and his head was sooty.

(CHUMAYEL MANUSCRIPT 42.22–43.3; TRANSLATION
BY KNOWLTON 2010, 55–57; AND VAIL, IN
VAIL AND HERNÁNDEZ 2013, 96n57)

NOTES

1. A remarkably similar text is recorded in Francisco de Avila's report on his mission to search out pagan idolatries in the region of Huarochiri east of Lima in the sixteenth century. It reads as follows: "They recount that in remote times the sun died. Because of its [the Sun's] death five days passed like nights. And then the rocks banged against each other. Furthermore, the mortars and grinding stones began to eat men. And the male llamas began to drive humans" (Urioste 1983, 18; translation by Quilter 1990, 46). Not only does the passage refer to the five days of darkness referenced in the Chumayel text, but it also includes an account of the "revolt of the objects" similar to that seen in the *Popol Vuh* (discussed in the section "Accounts of Previous Suns or Eras"). The Chorti believe an eclipse that lasts more than a day will bring the end of the world (Milbrath 1999:26).

2. Throughout my chapter, I use the epigraphic spellings (*k'atun*, Wayeb, Oxlahun Ti'K'uh, etc.), except when directly quoting from Colonial sources (as in the appendix). A *k'atun* is a period of approximately 20 years, equaling 20 *tuns* of 360 days each. An era is not a specific period of time but may correspond to a world age, over which a specific Sun presides in Central Mexican cosmology. The concept of previous Suns may also be found in Postclassic and Colonial Maya texts (see Vail and Hernández 2013, chap. 7).

3. The numbers designated by a "T" refer to entries in the glyph catalog developed by Eric Thompson in the 1960s (Thompson 1962). The three-digit alphanumeric codes were developed by Macri and Looper (2003) for Classic period contexts and applied to the codices by Macri and Vail (2009). The two types of eclipse glyphs may be seen suspended from the skyband formed of the crocodilian's body in Figure 7.1.

4. Literally translated, this refers to the end of speech.

5. It is important to note that, while the earliest written version known of the *Popol Vuh* dates to the middle of the sixteenth century, many of the narratives included in this text are depicted in iconography dating from as early as the Late Preclassic period (400 B.C.–A.D. 200) (Taube et al. 2010) and are a common component in Classic period contexts, particularly polychrome vessels, as Michael Coe (1973) first discussed. Nevertheless, the extensive parallels to Central Mexican mythological narratives (see Vail and Hernández 2013, chap. 3) suggest that it was most likely written by scribes well versed in the Mexican tradition.

6. In Classic period Maya mythology, God L plays a similar role to that of Seven Macaw in the *Popol Vuh* (Vail and Hernández 2013, 448; see Martin 2006 for his discussion of God L). It is likewise of interest that he, too, is portrayed as a Venus deity on several occasions (Closs 1989; Taube 1992, 79).

7. These associations were made many years ago, based on linking the former with the nine layers of the underworld and the latter with the thirteen layers of the celestial sphere (Thompson 1970, 338). It has been argued more recently, however, that the

association of the underworld with nine layers and the celestial region with thirteen is a European introduction from the Colonial period (Nielsen and Sellner, forthcoming; Vail, forthcoming [b]). Nevertheless, there is good evidence to relate the Bolon Ti' K'uh with the underworld region and the Oxlahun Ti' K'uh with the sky (see Vail and Hernández 2013, 469 and appendix 7.1 above). It should be noted that, like the quadripartite rain deities, the Bolon Ti' K'uh (as well as the Oxlahun Ti' K'uh) are sometimes referenced as a single entity and at other times as a plurality (Knowlton 2010, 57).

8. The Yucatec Maya from Chan Kom describe the Ah Musen Kab as a type of bee that resides at Cobá (Redfield and Villa Rojas 1967, 117). Moreover, Venus in the form of a diving insect (identified by Milbrath 1999, 162, as a bee or a wasp) plays the role of an eclipse agent on page 58b of the Dresden Codex (Closs 1989, 405–6).

9. The terms *acatl* and *tonal* are Nahuatl words that the scribe subsequently Mayanized.

10. It is of interest in this regard that only five of the almanac's frames are associated with an interval of 8. This suggests the possible correlation of five Venus cycles (of 584 days) with eight solar years (of 365 days). The iconography of the frames in question, however, provides little evidence in support of a Venus association, with the exception of the frame previously discussed with the blindfolded deity.

11. Vail and Hernández (2013, 448–49) identify the Bolon Ti' K'uh and the Ah Musen Kab as related complexes of Venus deities. The Ah Musen Kab may be associated specifically with the heliacal rise aspect of the planet, as suggested by the previous discussion.

12. A possible glyptic spelling of Xulab occurs in the Dresden eclipse table above the picture on Dresden 53a. It consists of 3MB/T267 (*xul?*), 1SD/T613 (the syllable *le*), and AP9?/T757? (possibly the syllable *ba*). If this interpretation is correct, Xulab is named as the being responsible for damage to the earth and sky lords; this is followed by a reference to an eclipse season, as indicated by the pairing of solar and lunar eclipse glyphs in the caption (H. Bricker and V. Bricker 2011, 302).

13. *u mu'uk kakatunal*, transcribed as HE6? YSA AA₁ // AA₁ AA₁ 3M₄ PX₄ AMB or Tr? 648:25 T25:25:90.537:534.

14. A similar episode occurs in the *Popol Vuh*, where the brothers Zipacna (the Maker of Mountains) and Cabracan (the Destroyer of Mountains) are robbed of their power and buried within the earth. Cabracan, conceived of as a “bound giant buried beneath the mountains,” is still associated with earthquakes by the K'iche' Maya today (Christenson 2007, 111n219).

15. The collocation is read as follows: *wak*, ‘six’ (oo6/TVI), *yi-chi*, *yich* ‘his face, eye’ (ZUH/Tr17 MR7/T671), *abaw* ‘lord’ (2MI/T168).

16. Eclipses are also mentioned on Paris 4 and 10, although it is not clear if there is a direct association with Wak Yich Ahaw.

17. Although the locative is not specified in the text, it is clearly intended to be the sky, based on the associated picture.

18. Similar sacrificial scenes appear on pages 49–53 of the Codex Borgia, a Post-classic manuscript from the highland Mexican tradition. In each of its frames, trees are depicted growing from the chest cavities of various deities; the final frame shows a bloodletting ritual associated with a maize plant representing the central direction. Each of the trees (including Borgia 53) is different in form, with that on Borgia 52 most closely resembling the Dresden example.

19. The text may be transcribed as follows:

T15.736b:140 T267:613 T1.648:25
2S8 SCC AMB // 3MB 1SD // HE6 YSA AA1
ah-kim(il)-la xul?-le? u-mu(k)-ka
ah kimil xul? u muk
dead person end of? the evil omen

20. Like that from the Chumayel, the Dresden text also refers to events taking place in primordial time (Vail and Hernández 2013, 252–57).

21. The relevant portion of the caption reads as follows:

T1.648:25 T544:116 T15.736b T267v:548:24 T267v:544
HE6 YSA AA1 // XQ₃ 1S₂ // 2S8 SCC // 3MB XH₂ 1M₄ // 3MB XQ₃
u-mu-ka k'in-ni ah-kim(il) xul?-haab-li xul?-k'in
u mu'uk k'in ah kimil xul? haabil xul? k'in
his evil omen, the sun, dead person end? of years, end? of days [or the Sun]

22. See also note 1.

23. In the *Popol Vuh*, the first dawn (i.e., the initial rise of the current Sun) is made possible by the appearance of the Morning Star in the predawn sky (Christenson 2007, 228). It is likely that the same relationship is being expressed here: the dawn of Oxlahun Ti'K'uh occurs because of the Bolon Ti'K'uh. This suggests that the former is the Sun and the latter Venus.

24. These four lines refer to the destruction of the world. It is likely that this was presaged by an eclipse, which would explain the line referring to Oxlahun Ti'K'uh's din. One of the means of scaring off the creature causing an eclipse mentioned in both ethnohistoric and ethnographic sources is the making of a tremendous racket (Closs 1989).

25. As a number of scholars have previously discussed, the scene on page 74 of the Dresden Codex (see figure 7.1) that shows the crocodilian in the sky, from whose mouth water gushes, appears to be a version of the ascent of Itzam Kab Ayin referenced in this text (Knowlton 2010, 74; Vail and Hernández 2013; Velásquez García 2006).

26. Although a flood was initiated by the rise of the crocodilian into the sky, it is subverted by the cutting of Itzam Kab Ayin's throat, either by (or at the direction of) the Bolon Ti'K'uh, or Venus gods (Knowlton 2010, 74; Vail and Hernández 2013).

27. These two lines refer to the formation of the earth from the crocodilian's body.
28. The actions of blindfolding and blinding form a significant theme of the *k'atun* 11 Ahaw narrative in the Books of Chilam Balam (Knowlton 2010; Vail and Hernández 2013), as previously discussed.
29. *taab* [tab] may also mean 'rope' or 'cord' (Hofling and Tesucúan 1997, 584).

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*The Maya Deluge Myth and
Dresden Codex Page 74**Not the End but the Eternal
Regeneration of the World*

JOHN B. CARLSON

Legends of the destruction of the world by flood or a great celestial deluge (here in the sense of a devastating downpour or unceasing torrential rains) are almost universal in human mythology. The wonderful compilation assembled and edited by Alan Dundes (1988) contains many useful essays. Indeed, cataclysmic floods and deluges are not uncommon on geological timescales, and Dorothy Vitaliano (1973, chap. 7) presents a well-researched summary of accounts from around the globe recorded in text and oral tradition. The stories that we are most familiar with in the Western world, which would include the Americas beginning soon after European contact, all began in or near ancient Mesopotamia and the greater Mediterranean region (Cohn 1993). They acquired worldwide currency through the spread of the Judeo-Christian scriptures with the story of Noah's Flood as a punishment for a fallen, sinful world by a wrathful God (Cohn 1996). In addition, the Greek legend of the sunken island city of Atlantis, which comes down to us in Plato's dialogues from the fourth century B.C., has also shaped virtually all subsequent mythos of "lost tribes and sunken continents" (Waughope 1962) that were, and remain, current in many speculations about the origins of the native peoples of the Americas.

Stories of catastrophic floods and deluges probably have much deeper human archetypal roots, our origins in the amniotic womb before birth and rites of bathing and baptismal rebirth in many religions. Independent traditions did exist in Prehispanic Mesoamerica

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(certainly in highland Central Mexico), however, and also very likely among the ancestral Maya peoples and others, including the Gulf Coast and Isthmian Olmec (probably deriving from well before 1500 B.C.), who often experienced destructive flooding in their riverine environments as well as from frequent hurricanes and severe thunderstorms. One particularly thorough reference, by Fernando Horcasitas (1988), is the best summary I know of that deals comprehensively with an analysis of the “deluge myth” in Mesoamerica, including the relevant sources for the Maya.

It is indisputable that the Late Postclassic period (A.D. 1300–1519) Nahua-speaking Mexica peoples (whom we often call the Aztecs) did have cosmogonies that involved the creation and violent destructions of four previous worlds or “Suns” by the same deified calendrical forces of nature that created them. The principle of “Motion” (Ollin) created the present Fifth Sun, which the Motion of the Earth, or Earthquake (*tlalollin*), was destined to destroy. Not only is this “Five Suns” cosmology recorded in several forms after the Spanish conquest in various “Legends of the Suns,” including depictions in the Codex Ríos (Vaticanus 3738 Codex 1979) (figure 8.1), but also spectacular precontact representations exist in the famous Aztec Calendar Stone (figure 8.2) and at least three other Stones of the Five Suns (Matos and Solís 2004). On these precontact carved monuments and in the canonical versions of the legends, the Fourth Sun of Water, Atonatiuh, was created by the Aztec water goddess Chalchiuhtlicue (She of the Jade Skirt), and subsequently destroyed by her in a cataclysmic flood. This Central Mexican cosmogonic epic is widely confused with Maya cultural traditions in popular culture as well as in academia (Carlson 2011b).

For the Maya, all the surviving accounts of a flood likely derive in part from Postconquest (A.D. 1519–1697) sources, and all seem to have been influenced, at least to some degree, by Judeo-Christian biblical stories as well as by the non-Maya Central Mexican tradition (Horcasitas 1988). This was the case whether we are reviewing the accounts of a flood in the sixteenth- to seventeenth-century Quiché Maya *Popol Vuh* (Christenson 2007), the mid-sixteenth-century account of Maya life in Yucatán chronicled by Fray Diego de Landa (Tozzer 1941, 136n633), or the various legends and prophecies written down later (in Mayan languages but with our script), such as in the syncretic Yucatecan ritual books known collectively as the Books of Chilam Balam like the Chumayel (Roys 1933) and Tizimín (Edmonson 1982). None of these sources has any connection with the end of the thirteenth baktun cycle in 2012, despite such speculations among some scholars, including Michael Coe (1992, [1966] 2011), where this idea was first introduced in the context of the 2012 phenomenon (Carlson 2011a, 2011b; Hoopes 2011).

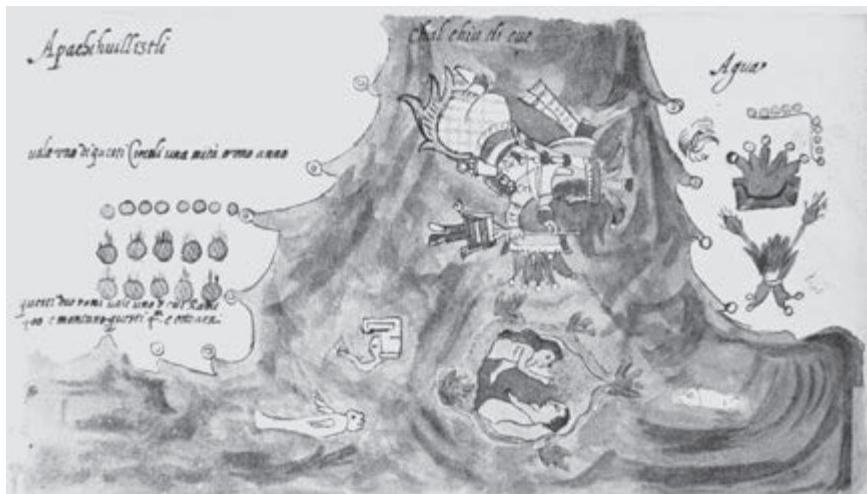


FIGURE 8.1. *The destruction of the Fourth Sun, Nahui Atl Tonatiuh, by the cosmogonic Aztec water goddess, Chalchiuhltlicue, from the Legend of the Suns, portrayed in the early colonial Mexican Codex (Vaticanus 3738 Codex [Codex Rios] 1979, facsimile fols. 4v/5r).*

Controversy surrounds the unique image and accompanying fifteen-glyph text (three rows, five columns, now half destroyed) painted on what is called page 74 of the Precolumbian Maya Dresden Codex (Deckert 1962, 74; Deckert and Anders 1975; Kumatzim Wuj Jun 1998) (figure 8.3). Beginning in 1825–1826, the artist Agostino Aglio, who prepared drawings for the Kingsborough (1831) edition, numbered the sequential pages erroneously, but the original order has now been established conclusively. The four “New Years” pages 25–28 follow page 74. The idea that this image represents a cataclysmic world-destroying deluge certainly first enters the world of Maya studies through the work of Ernst Wilhelm Förstemann (1886, 80), written in the late nineteenth century and synthesized in the publication of his great commentary (in German, Förstemann 1901) and subsequently translated into English in 1906. After a very thorough description, he concluded, “this page can denote nothing but the end of the world, for which the serpent numbers [on previous pages] have prepared the way. Perhaps what looks like a zero above the [day] sign *Eb* in the stream of water [pouring out of a jar held by the Old Goddess “O”] may likewise point to the calamity” (Förstemann 1906, 266). (There is actually a five-bar over a one-dot over a shell-zero above the *Eb* day sign, or 5.1.0 days related to the 4 *Eb* base date.) He expresses this dire interpretation as a certainty, seemingly entertaining



FIGURE 8.2. *The Aztec Calendar Stone or “Stone of the Five Suns,” located in the Sala Mexica, National Museum of Anthropology and History, Mexico City (photograph in public domain).*

no doubt, notwithstanding the limited sources available to him in the late nineteenth century. I strongly suspect that this idea might have originated much earlier than with Förstemann, however, perhaps even in the mind of the original owner, Johann Christian Götze, who acquired the codex in 1739 and donated it to the Royal Library in 1744. Others saw and reproduced a few pages of the Dresden (but not page 74), including Baron Joseph Friedrich Von Racknitz and Alexander von Humboldt (Coe 1963), but it was Edward King, Lord Kingsborough (1831), who produced the first complete published version (with colored drawings by Agostino Aglio) of the Dresden Codex that included page 74 in 1830–1831. It was available to interested researchers over the next fifty years before Förstemann’s (1880) first excellent chromolithographic facsimile edition appeared in 1880, leading to his published apocalyptic interpretation in 1886.



FIGURE 8.3. *The so-called “Maya Deluge” scene on Dresden Codex 74* (Förstemann 1880, 74; public domain; see Förstemann [1901, 1906] for commentary).

I have searched the published writings of Lord Kingsborough, Charles Étienne Brasseur de Bourbourg (1857–1859), and Augustus and Alice Le Plongeon, in particular, for earlier suggestions of the Dresden page 74 deluge hypothesis because of their well-known interests in Atlantis and the “Lost Tribes of Israel” speculations, but I have yet to find a confirmation in the published sources (*Kumatzim Wuj Jun* 1988; Desmond 2009). It is clear that these pioneering students of the Dresden Codex were steeped in the Judeo-Christian apocalyptic traditions beginning with Noah’s Flood (Cohn 1993, 1996; Dundes 1988) and including the late first-century Revelation (Apocalypse) of John of

Patmos, the final book of the canonical Western Christian bible (Cohn 1993). From Götze to Förstemann, all would have been well acquainted with medieval visionary apocalyptic art such as Albrecht Dürer's fifteen woodcuts of John's Apocalypse, first published in 1498 (Hütt n.d., 2:1510–11; Kurth [1927] 1963, 7–44, 115). The “Dragon with the Seven Heads” (1497/98) (figure 8.4) is of particular relevance when compared with the Dresden Codex page 74 celestial “Dragon.” As pointed out to me by John Hoopes (personal communication, 2011), this image also shows water pouring forth from the mouth of the primary head of the winged seven-headed Dragon of the Apocalypse flooding the earth. Both scenes are celestial scenes, with Dürer's Judeo-Christian God presiding in the starry heavens surrounded by angels with the winged “Woman of the Apocalypse” standing on the crescent moon, a visual parallel to the Old Goddess O in the Maya heavens pouring forth her waters. She is pictured below celestial downpour-producing solar and lunar eclipse motifs appended to the body of the Dresden Skyband Dragon. Such well-known powerful apocalyptic imagery may well have influenced Förstemann, as well as his predecessors, in envisioning the Dresden scene as portraying the violent end of a Maya world age, a vision that has survived well over a century in scholarly discourse and has now entered global popular culture, which reached its crescendo around December 21, 2012. Future examination of the primary sources as well as other more obscure nineteenth-century publications may well prove fruitful in finding earlier references. Brasseur de Bourbourg (1857–1859) seems to have been the first to suggest that the Dresden Codex derived from the Maya culture, rather than some other “Mexican” civilization, but the flood interpretation would have made sense to any of these earlier investigators with their typical nineteenth-century perspectives.

Ernst Förstemann's interpretation appeared in scholarly publications that were accessible to only a few, but it was soon embraced by one of the great twentieth-century Mayanists, Sylvanus Griswold Morley, who was also a notable popularizer with an interest in the romantic adventure literature of his day. His prose was far more flamboyant than that of Förstemann. In his synthesis, *An Introduction to the Study of the Maya Hieroglyphs*, Morley (1915, 32) writes:

Finally, on the last page of the manuscript, is depicted the Destruction of the World . . . Here we see the rain serpent, stretching across the sky, belching forth torrents of water. Great streams of water gush from the sun and moon. The old goddess, she of the tiger claws and forbidding aspect, the malevolent patroness of floods and cloudbursts, overturns the bowl of the heavenly waters. The cross-



FIGURE 8.4. One of fifteen woodcuts by Albrecht Dürer, published in 1498, depicting scenes from the late first-century A.D. biblical Book of Revelation written by John of Patmos; the seven-headed Dragon of the Apocalypse is shown disgorging a flood of water upon the earth (Hütt n.d., 2:1510; Kurth [1927] 1963, 7–44, 115; open-source photograph).

bones, dread emblem of death, decorate her skirt, and a writhing snake crowns her head. Below with downward-pointed spears, symbolic of the universal destruction, the black god stalks abroad, a screeching bird raging on his fearsome head. Here, indeed, is portrayed with graphic touch the final all-engulfing cataclysm.

According to Michael Coe (personal communication, 2011), Morley had read the romantic works of H. Rider Haggard (1895, 339), in particular, *Heart of the World*, in which the tale of the destruction by flood of “that ancient and beautiful city, Heart of the World, [where] there remained nothing to be seen except the tops of trees and the upper parts of the pyramids of worship rising above the level of the lake.” This included the death by drowning of the noble heroine, named Maya. It was suggested by Morley himself that reading this book influenced him as a young student to choose studies of the Maya as his profession.

The interpretation of Dresden Codex page 74 as the “destruction of the world by flood” might have remained in scholarly obscurity for decades, but Morley (1922, 130) included the picture (uncharacteristically in black and white, this time) in his influential *National Geographic* magazine article titled “The Foremost Intellectual Achievement of Ancient America,” where equally evocative language appears. Morley’s personal and professional influence as well as Förstemann’s scholarship have convinced several generations of academics as well as the general public of this interpretation, and few have questioned it. It was included in Morley’s (1946, 214–15) monumental popularization, *The Ancient Maya*, with a drawing of page 74 and the caption “Destruction of the world by water,” and the idea has remained in print through later editions into the twenty-first century with two subsequent co-authors/editors following his death in 1948 (Morley and Brainerd 1956, 188–89; Sharer and Traxler [1994] 2005, 727–30). Other widely distributed publications of the Dresden Codex, such as the edition of drawings of the Maya codices with page-by-page commentary by Villacorta and Villacorta (1930, 158–59), continued this interpretation following the “*opiniones autorizadas*” that this scene represents “*la destrucción del Mundo*.” Another example of scholarship combined with popularization that derived directly from Morley’s influential perspective is found in the work of popular mythologist Joseph Campbell (1949, 374–75). In his widely read *The Hero with a Thousand Faces*, he quotes extensively from Morley’s original 1915 study for his comparative chapter “Dissolutions” and the section “End of the Macrocosm,” with a discussion that opens with “The Mayan version of the world-end is represented in an illustration covering the last page [*sic*] of the Dresden Codex.”

One of the few contemporary Mayanists of note to question the deluge interpretation was J. Eric S. Thompson (1971; 1972, 88–89), who left the door open to an alternative explanation. After giving a thorough description of the scene (figure 8.3), including the generally agreed upon identifications of the aged goddess pouring water from the jar as Old Goddess O and the black martial deity below as God L, he informs the reader: “It has been supposed that the scene shows destruction of the world by flood. Although one would expect to find the other destructions of the world [mentioned in colonial sources] also illustrated, I think one must accept that explanation for two reasons [which he then outlines].” He continues by describing the few remaining glyphs of the original fifteen-glyph text, which include Ek Kan (Black Sky), Ek Cab (Black Earth), and the names of God B (Chaac, the rain deity) and Goddess O (Chac Chel/Ix Chel), but then hedges his Dresden page 74 analysis by saying: “In view of the preceding pages treating of rain and drought, it seems possible that the flood scene comes to symbolize the annual start of the rainy season. This page thereby would have a double function: to recall the flood and to glorify the arrival of the rains.” More recently, French epigrapher Michel Davoust’s (1997, 256–57) excellent detailed commentary on the Dresden continues the interpretation that the “blue color” on the lower border of the page, below the flow of water descending from the celestial monster’s mouth, reinforces the idea that the scene represents “*un déluge terrestre*,” but he does not go so far as to suggest that this destroys the earth. A careful inspection of page 74 (figure 8.3), however, shows that God L is kneeling comfortably on the solid ground. An epigraphic review and working interpretation of the surviving texts of Dresden 74 are provided in table 8.1.

At the top of Dresden Codex page 74 (figure 8.3) was a text of fifteen glyph blocks in three rows (1–3) and five columns (A–E). The first row is essentially obliterated, and there remain some questions about reading order. A transcription with readings and interpretations is offered, based on the work of previous researchers, such as Förstemann (1901, 1906), Villacorta and Villacorta (1930), Thompson (1972), Davoust (1997, 256–57), and Schele and Grube (1997), among others. The glyph blocks will be discussed in this order: A₂, A₃, B₂, B₃, etc., as Row 1 was destroyed long ago. In the transcription, I have followed Davoust (and most others) in indicating logographs in capital letters and phonetic (syllabic) units in lower case. Most of the transcriptions that follow are from Davoust (1997, 256–57), with minor changes, who also published his assessment of the relevant Thompson numbers. The interpretations are mine based on diverse sources. Due to the portion that is missing, the text cannot be read, but essential elements have been clear for many years. Nothing in

TABLE 8.1. Dresden Codex Page 74 Texts: Epigraphy and Interpretation

A₂: HA' POP CA'AN

Rain Sky Mat (throne of office)? related to the celestial seat of Storm God B (Chaac)?

A₃: NA' TUN (ni)

Mother of (or First) Stone or of the First Tun (360-day year).

B₂: EK' CA'AN (na)

Black (dark) Sky.

B₃: BA-CA-B(E)

Bacab title; or Skybearers—rain- and storm-related supernaturals.

C₂: EK' CAB (ba)

Black (dark) Earth.

C₃: CHAHC (ci)

Name glyph of the Maya rain and storm deity, Chaac (God B).

D₂: YA'?

?

D₃: CHAC CHEL

Name glyph of the Old Goddess O.

E₂: NOHOL

Direction to the south?

E₃: CUN NAL

Throne (platform) place?—a toponym.

Note: Celestial, terrestrial, or underworld location not indicated.

these glyph blocks indicates a cataclysmic destruction of the world by celestial deluge. In my interpretation, the references to black (or dark) sky and earth refer to what one experiences in the spring in Maya land with the onset of the rainy season, often with violent thunderstorms and downpours. Although the name of God L does not appear in the surviving text, it is most likely that it was among the five or six missing glyphs.

The Maya deluge myth has nonetheless continued unchallenged in the work of some Mayanists (Freidel et al. 1993; Schele and Grube 1997, 166–67; Taube 1992, 1993, 69–74; 1994, 653; Zender and Guenter 2003, 106, fig. 8; Velásquez García 2006; Houston et al. 2009, 26, fig. 2.8; Aveni 2009, 46–48; 2010, 56; Vail

and Hernández 2011, 453–54; Martin 2012). Mayanist Nikolai Grube has also continued to present the Maya deluge interpretation in a National Geographic TV (2009) film entitled *2012 Countdown to Armageddon*, as well as in his 2012 commentary in German (with finely produced color plates) on *Der Dresdner Maya-Kalender Der vollständige Codex* (Grube 2012). In the video, the narrator tells the viewer, “...the Maya believed that a catastrophic climate event would destroy the world.” Grube, holding a facsimile, then tells us, regarding the “final” page 74 of the Dresden Codex: “The last picture shows us the end of the world, the destruction of the world, by the Celestial Crocodile, or the sky, who is pouring out streams of water so that all life on earth would be destroyed.” In very few of these opinions, expressed by Maya scholars over the past century, has it been made clear whether this alleged deluge destroyed a past Maya creation or is destined to end our current world sometime in the perhaps not too distant future. Anthony Aveni (2009, 46–48), among others, has cautiously suggested, “This scene may refer to the destruction of a previous world by flood, specifically the world that ended on August 11, 3114 B.C., and appropriately enough, it comes at the end [*sic*] of the document, but it might also signify a seasonal torrential downpour.” In this regard, he follows Thompson’s (1972, 88–89) hedge that the famous scene may somehow refer both to the pluvial destruction of a world age and, at the same time, simply signify a torrential downpour. In any case, there is no evidence that any of these interpretations has anything to do with the completion of the current great baktun 13 era, the end of the present 5,125-year long count, on or near December 21, 2012. The only suggestion of such a connection from a recognized Maya scholar comes in Michael Coe’s (1992, 275–76) “Epilogue,” in which he leaves open the possibility of the end of the world based on beliefs of “Maya wise men all across Yucatán” and a katun prophecy from the Colonial period *Book of Chilam Balam of Tizimin*, which refers to “the great flooding of the Earth.” This prophecy is for a different katun—the ending of katun 13 Ahaw (Edmonson 1982, 38–41)—rather than the katun 4 Ahaw that was completed in 2012.

The school of Maya studies created by art historian Linda Schele, formerly at the University of Texas, Austin, has contributed in complex ways to the promulgation and elaboration of the continuing interpretation of Dresden 74 as a world-destroying deluge scene, both for the destruction of a previous epoch and perhaps also for the end of the present world epoch in 2012. In particular, collaborations in the 1990s with Karl Taube, David Freidel, and Nikolai Grube produced a bounty of cosmological models that have influenced both professional Maya studies and popular culture for a generation. This remarkable creative period, which Schele in Freidel et al. (1993, 107)

described as “the most exciting and intensive time of my intellectual life,” was driven, in part, by the ready availability of newly created “planetarium” software for personal computers coupled with the rapid pace of Maya glyphic decipherment and general access to reliable ancient, colonial, and contemporary Maya texts, images, and ethnographic and linguistic data. In *Maya Cosmos*, Freidel et al. (1993, 106–7) outline the concept, in collaboration with Taube and Grube, of the “Cosmic Dragon” on Dresden 74 as the Milky Way, “belching out the waters of the flood . . . the flood that ended the last creation.” The long-understood fact that page 74 of the Dresden is *not* the last page, but is followed by the so-called “New Years” pages 25–28, was brought into the discussion through Taube’s (1988) dissertation research, this aspect of which was popularized by him in 1993. This connected Maya year renewal rites of passage and, by inference, longer epochs of temporal renewal with the presumed destruction of the previous world by deluge as depicted on Dresden 74. Grube’s views were incorporated into the working model through his studies of the New Years pages in the Paris Codex (Love 1994), among other concepts (Freidel et al. 1993, 106), and many of these ideas were further refined a few years later at the Texas Maya Hieroglyphic Workshop of March 8–9, 1997, on the Dresden Codex (Schele and Grube 1997, 166). From the workbook notes and published transcription by Phil Wanyerka, it is once more made clear that in this new interpretation of the Dresden 74 text and scene—now with its connection to the 13 times four-year/four-directional Wayeb New Year’s temporal renewal cycles—included both past and possible future catastrophic destructions of the Maya world by celestial deluge. Schele and Grube (1997, 166, 167) clearly state, “This is a destruction scene”; they also identify the Cosmic Monster emerging from the skyband as the Milky Way, and state that in the page 74 scene, “the sun and moon are attached to it [the sky band] so that it very probably refers to the two points w[h]ere the ecliptic and the Milky Way cross.”

It is more likely that the Skyband Monster (usually depicted as bicephalic) is an embodiment of the ecliptic (Carlson and Landis 1985), but many have entertained these hypotheses since they were proposed in *Maya Cosmos*. In our comprehensive analysis of the skyband in Maya art and iconography¹ Linda Landis and I (Carlson and Landis 1985, 125, 134; Carlson 1982, 149, 153) had already concluded that the imagery of Dresden 74 represented the “rain-bringing attributes of the celestial dragon” in the so-called Maya “deluge” scene representing a “torrential Downpour.” The ubiquitous ancient pan-Maya imagery of a “bicephalic dragon,” whose body is usually a celestial “skyband,” shows water (and often “water group” symbols indicating precious liquid, a connection with sacrificial blood and the essence of the ancestors) pouring

down from the two composite saurian monster mouths to nourish the living earth. Particularly fine examples are found on the early Copán Margarita structure stucco panels (figure 8.5) and the later Palenque Palace House E stucco ornamentation over the northeastern corridor doorway (Carlson and Landis 1985, 117). Susan Milbrath (1999, 275–77) is among those few who have considered this and related models in her *Star Gods of the Maya*, questioning the deluge interpretation. In this extensive study, however, she did suggest that the shower of water “from the front end of the Cosmic Monster” symbolized “the rainy season section of the Milky Way,” rather than accepting the cataclysmic world-destroying deluge interpretation favored by Freidel, Schele, and Parker (1993, 106–7) in their *Maya Cosmos* and by Schele and Grube (1997, 166–67). Until recently, then, no plausible source known to this author had ever suggested these Classic period (A.D. 200–900) compositions as representing a world-ending deluge. The Dresden 74 image seemed to be the lone exception.

Beginning just before the turn of our present millennium, a series of extraordinary discoveries were made within the remains of Temple XIX at Palenque. Dating from the eighth-century reign of K'inich Ahkal Mo' Nahb, who became ruler in A.D. 721, the well-preserved images and texts potentially reveal a great deal more than was previously known about the mythology of the Palenque ruling dynasty, if the difficult texts can be deciphered and understood within the context of the whole corpus from the site. Based in particular on a text from Passage S-2 of the Hieroglyphic Platform, epigrapher David Stuart (2005, 68–77, 176–80), in his monograph *The Inscriptions of Temple XIX*, has suggested that the head of the bicephalic serpent (a well-known supernatural crocodile or caiman with deer hooves and associated “star” or “Venus” glyphs in the deer ears and eyelids, which he calls the “Starry Deer Crocodile”) was decapitated and associated with world creation and destruction events. These ideas were also presented in conjunction with art historian Erik Velásquez García's (2006) study of these new data and ideas as “The Maya Flood Myth and the Decapitation of the Cosmic Caiman.” A further contributor to these syntheses has been archaeologist Karl Taube, who summarized his thoughts in a 2010 catalog essay for the exhibition *Fiery Pool: The Maya and the Mythic Sea*. All of these scholars freely use a pan-Mesoamerican approach citing archaeological, ethnohistoric, and ethnographic sources ranging across time and culture from highland Central Mexico, the lowland core of the Maya sphere, to Colonial and contemporary Yucatán. Together, these complex and imaginative arguments are used to create a hypothetical ancient Maya (and Mesoamerican) mythos supporting the world-ending deluge interpretation of Dresden 74 (figure 8.3).



FIGURE 8.5. South stucco panel of the Copán Margarita structure portraying the emergence of the Copán dynastic founder, *K'inich Yax Kuk' Mo'*, emerging from the "9-Place" of origin. The scene is framed by the bicephalic celestial saurian Skyband Dragon. The dragon head on the right shows a downpour of precious liquid, probably blood transformed into water, nourishing the earth. (Drawing by David Sedat after Carlson 2007, 94, fig. 2a.)

Problems begin with the epigraphic uncertainty of the Passage S-2 text, and Stuart's (2005, 68) summary gives a sense of the state of decipherment and interpretation: "On the day 12.10.12.14.18 [before the present long count era] 1 *Etz'nab* 6 *Yaxk'in*, a 'Starry Deer Crocodile' (or possibly two aspects of that cosmic entity) is (or are) decapitated, perhaps at the hands of GI. Several glyphs are difficult to decipher, but we find a reference to some deity as a 'fire-driller.' The passage closes with a reference to the forming or construction of some object associated with GI. The theme seems to be world creation."

I found two levels of difficulty in relating the arguments and methodologies of these three researchers, in particular, to a convincing case that the scene on Dresden 74 depicted a cataclysmic deluge. For just one illustrative example, Stuart (2005, 178, fig. 144) and Taube (2010, 205, fig. 1) both use Taube's

redrawing of a portion of the drawing of a recently discovered mural fragment from Mayapán, northern Yucatán, published by Barrera Rubio and Peraza Lope (2001, 442, fig. 31) as well as some comparative material from those authors (figure 8.6). The surviving mural is quite incomplete, but appears to show a watery scene with fish, a serpentine creature (perhaps a shark or “water serpent,” only the tail half of which is preserved), a cayman or crocodile, and a human figure, but the aquatic scene is painted vertically as if these are flows of water pouring down from above. One of the fish has been shot through from the top with an atlatl dart, however, and a dart through the underbelly also pierces the crocodile, which is already bound around its front legs and around the jaws. What does this mural fragment represent—a mythological scene perhaps involving sacrifices to bring the rains, or could it be the celebration of a fishing and crocodile-hunting story? These are hypotheses. Taube (2010, 204–5), who shows the scene erroneously rotated 90 degrees so that the human and aquatic creatures appear to be swimming, writes: “. . . early colonial Yukatek Maya accounts describe the mythic crocodile Itzam Kab Ayin, sacrificed to create the world after the flood. A recently excavated mural from Mayapán graphically portrays this episode, with a bound and speared crocodile floating in water with other sea creatures.” Stuart (2005, 178–79), who has the drawing correctly oriented, writes that

Itzam Cab Ain, as Taube . . . has shown, the Yucatec name for the crocodile so widely depicted in Classic period art, including its Starry Deer–Crocodile aspect mentioned at Palenque. This story is of course a variation on a similar narrative well known from Central Mexican mythology, wherein Quetzalcoatl and Tezcatlipoca kill the Earth Monster (a zoomorphic aspect of Tlaltecuhtli) and create the earth from his dismembered body parts (Taube 1993, 69–70). Karl Taube (personal communication, 2003) recently pointed out to me a clear representation of this event in a Late Postclassic mural excavated at Mayapan in Structure Q.95 (Barrera Rubio and Peraza Lope 2001). The crocodile has been speared rather than decapitated, and the human figure above the reptile displays the distinctive shell pectoral [?] of Quetzalcoatl. If we assume GI is indeed the actor behind the crocodile sacrifice recorded in [Palenque] Temple XIX, we can point to another strong parallel between these two deities so removed from one another in time and space.

It is not obvious, from the evidence, that the bound and wounded crocodile in the Mayapán mural fragment is either Itzam Cab Ayin or the Starry Deer Crocodile. It does not have deer hooves and looks nothing like the Sky Band Monster of Dresden 74, which does not indicate that it has been

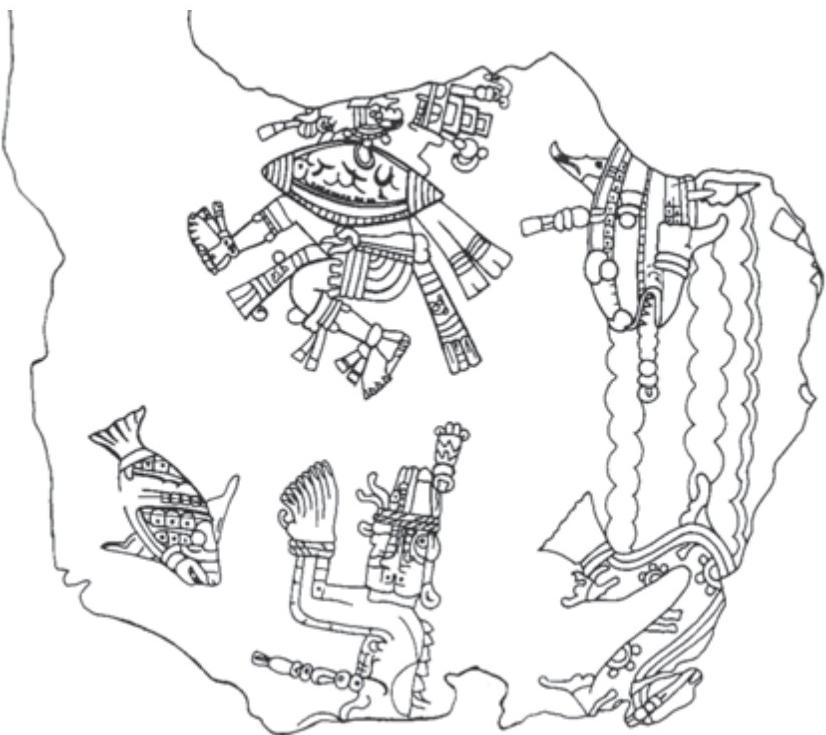


FIGURE 8.6. Lower portion of a polychrome mural fragment from the Postclassic “Templo del Pescador” (Structure Q.95) at Mayapán, Yucatán. Although most of the scene was destroyed in antiquity, what remains shows an elaborately dressed lower torso of a human figure, with a large shell pectoral pendant, surrounded by a minimum of four aquatic creatures: two fish, a large “water serpent”, and a crocodilian. The background is painted in shades of Maya blue with waves or rivulets rippling across the scene from top to bottom, likely representing rain pouring down from above rather than waves in a body of water. The scene is clearly related to the sacrifice of these creatures because only the one small fish (to the left) has not been shot through with an atlatl dart. (The butt of the dart piercing an additional sacrificed creature survives at the far right.) Of central interest for the present discussion is the captive crocodilian (front half preserved and significantly facing upward rather than downward) with its front and probably rear limbs and jaws bound with cords. It has also been speared through the belly with the dart indicating that it had already been captured and bound before sacrifice. Nothing in this pluvial scene would suggest decapitation sacrifice or dismemberment of the crocodilian, nor is there any obvious connection with the mythological Itzam Cab Ain or the saurian Skyband Dragon heads that descend from the heavens, such as the one depicted on Dresden Codex page 74. (After drawing by José Francisco Villaseñor in Barrera Rubio and Peraza Lope 2001, 442, fig. 31 and lámina 32.)

sacrificed, nor does it have a deer ear with star symbols in it or star symbols on its eyelid.

Even if the decipherments and interpretations suggested in Stuart's monograph, and supported and used by Velásquez and Taube, are working hypotheses regarding the decapitation of the so-called "Starry Deer Crocodile," I do not agree that they are related to the scene, texts, and contexts of the celestial Skyband Dragon of Dresden 74.

DESCRIPTION AND ANALYSIS OF DRESDEN CODEX PAGE 74

My view of Dresden 74 is that this page represents nothing more than the generous nourishing of the earth by downpours of life-giving rain, at the seasonal springtime onset of the rainy season, invoked by pan-Mesoamerican practices of Venus-regulated warfare and subsequent ritual sacrifices (Carlson 1982, 2011a, 2011b; Carlson and Landis 1985). At the top of the scene is one head (of likely two) of the Bicephalic Celestial Sky Band Dragon, a well-known ancient composite creature with ophidian and saurian (crocodile or caiman) attributes, often including deer hooves, with Skyband symbols decorating the serpentine body (Carlson and Landis 1985). In this case, from left to right, the symbols are Great Star/Venus (*Ek'*), Sky (*Kan*), Sun (*K'in*), and Darkness (*Akbal'*). In other Mesoamerican cultural contexts, such as at Teotihuacán, Toltec Tula, and Maya Chichén Itzá, the celestial form of the Plumed Rattlesnake, the Feathered Serpent as Venus, pours forth red and blue flows of liquid, sacrificial blood and water, to assuage the thirst of the parched earth (Carlson 1990, 1991, 1993). Teotihuacán representations such as the "Wagner" murals, removed from the Techinantitla compound (figure 8.7), and the descending Feathered Serpent architectonic columns of Toltec Tula and Maya Chichén Itzá temples (figure 8.8) represent this creative source of rain from sacrificial blood. If the descending "Serpent of Light and Shadow" phenomenon that occurs at the Temple of Kukulkan at Chichén Itzá around the time of the equinoxes (figure 8.9) was intentionally designed, this compelling display plausibly represents the descent from the celestial temple of Kukulkan of the Plumed Rattlesnake, who conveys the sacrificial blood down to the Venus platform below and then on to the sacred cenote of sacrifice, the chthonic home of the rain gods, Chaac and probably Tlaloc as well (Carlson 1990, 1991, 1993, 1999). I have found these sources to be among those most relevant to the interpretation of the Dresden 74 scene with regard to a wide range of greater Mesoamerican supernatural celestial or terrestrial "water serpent" traditions (e.g., the Chicchan of the Chorti Maya and the tornadic Viboras de Agua of the Mexican highlands). There is



FIGURE 8.7. Fragment of the “Wagner Murals” from the Techinantitla compound in ancient Teotihuacán, Central Mexico (ca. A.D. 650–750). The complete mural composition depicts the full body of the quetzal-plumed serpent in the sky above a series of flowering trees, pouring down flows of red and blue liquid (blood and water) to nourish the earth. This plumed celestial dragon, which was also a manifestation of Venus, corresponds to the Kukulkan of the (Yucatec) Maya and Quetzalcoatl for the Nahua-speaking Toltecs and Aztecs. (After Berrin and Pasztory 1993, 202, cat. no. 50, reprinted with permission.)

nothing in the Dresden 74 image to indicate that the flows of blue water from the mouth of the Celestial Dragon, from the solar and lunar eclipse symbols that hang from the sky band, or from Goddess O’s overturned water jar represent anything other than welcome rain from springtime thunderstorms for the thirsty earth. Furthermore, Knowlton (2003) has plausibly interpreted these eclipse symbols as specific eclipses related to the rainy season, not to a cataclysmic flood due to downpours (a most unlikely scenario for the Yucatecan karst), and noted that the other examples of sky bands and eclipses in the Dresden Codex are associated only with auguries for rain and associations with the rainy season. For anyone who has witnessed the Yucatecan lightning and thunderstorms that bring great cloudbursts, the arrival of the Dark Sky and Dark Earth, referred to in the accompanying text, are seen as nothing but a blessing to the Maya farmers for their parched milpas.

The invocation of the rains theme is central to all of the surviving Maya codices, and blood and other sacrifices are at the heart of the equation of what



FIGURE 8.8. One of two descending Plumed Serpent columns that once supported the lintel over the doorway of the Temple of the Warriors, Chichén Itzá, Yucatán. Similar columns representing the descending Kukulkan (Quetzalcoatl) are found at other temples at Chichén Itzá, such as the Temple of Kukulkan (see figure 8.9) and at Toltec Tula in Central Mexico (photograph by John B. Carlson).



FIGURE 8.9. *The equinox descent of the “Serpent of Light and Shadow” on March 21, 1989, seen about an hour before sunset on the northwest balustrade of the Temple of Kukulkan (El Castillo) at Chichén Itzá, Yucatán. The great Plumed Serpent head at ground level is completely illuminated below the pattern of seven triangles of light (photograph by John B. Carlson, Carlson 1993, 137, fig. 1; reprinted with permission).*

must be given to the gods in order to receive sustenance. Supporting examples may be found in the Madrid Codex (Anders 1967, 50–51) (figures 8.10, 8.11), where on page 50 Chaac (God B) pours rain from water jars and the Young Moon Goddess I pours rain from a celestial water serpent. In the scene below, Goddess O produces rain from her armpits and from under her skirts. Chaac, in his Scorpion Man manifestation on page 51 (Carlson 1990, 1991), produces rain and is surrounded by four celestial mammals that disgorge flows of water from their mouths. Nowhere in any of the Maya codices are there representations of floods, as there are in Central Mexican sources (e.g., Vaticanus 3738 Codex 1979) (figure 8.1). The related almanac pages that immediately precede Dresden Codex page 74 only depict the same beneficial blue streams of rain falling from some of the glyptic compositions. Previous almanacs with closely related iconography, such as on Dresden 68 (figure 8.12), show scenes with sky-bands, the abbreviated body of the Celestial Monster, with symbols for clouds, solar and lunar eclipses, evocations of the rain god, Chaac (God B), and rain flows from the sky to nourish the Maize God E.



FIGURE 8.10. *Madrid Codex* 50 (Anders 1967, 50): top, images of the blue-painted Maya rain god Chaac (God B) and Goddess I standing on a celestial water serpent pouring out the rains from water jars; bottom, Old Goddess O issuing water from her armpits and from under her skirt and holding rain producing beasts (with the blue God B seated on her left foot).

Those four Dresden Codex New Years pages 25–28, which immediately follow page 74, are involved with a complex but vital relationship of the annual springtime commencement of the rains with vastly greater periods of calendrical world renewal dealt with previously in the codex. In the key scene on Dresden 74, the black God L appears, once again poised aggressively with his spear-thrower and darts, as he does as a Morning Star sacrificer on page 46 of the Venus almanac (figure 8.13). Goddess O, his female aspect or consort (Carlson 2007, 2011a, 2011b), who is the personification of midwifery and



FIGURE 8.11. *Madrid Codex 51* (Anders 1967, 51): top, a blue-painted celestial Chaac (God B) in a Scorpion sacrificer manifestation (Carlson 1991, 1993), pours down a torrent of rain and is surrounded by four water beasts labeled with the names of the four world quarters; bottom, the blue Chaac is perched on a blue celestial water dragon (open-source images).

medicine (Taube 1994; Carlson 2011a, 2011b) in her jaguar-clawed primal form, with decorated apron and skirt of crossbones and “death eyes,” performs the ancient pan-Mesoamerican ritual of pouring water from a jar to invoke the spring rains with pluvial “sympathetic magic.”

The eternal springtime return of Maya earth-dwelling gods of lightning and thunder, rain and wind, rising from their mountain caves and cenotes as mists to take form in their celestial storm clouds, required active human participation. The essence of the Dresden Codex divinatory almanacs, in the hands of the ancient Maya daykeepers, was to guide their prognostications, ritual



FIGURE 8.12. Dresden Codex 68
(Förstemann 1880, 68; public domain; see
Förstemann [1901, 1906] for commentary).

performances, and sacrifices to ensure the cyclical regeneration of the world of life, their ancestors, and their gods.

Acknowledgments. It has now been more than forty years—two full katuns have turned—since I first met Tony Aveni and his wife Lorraine in June of 1973 in Mexico City at that first symposium, which became *Archaeoastronomy in Pre-Columbian America* (Aveni 1975). Along with his Mexican colleague, the *arquitecto* Horst Hartung, Tony convened a remarkable gathering of individuals dedicated to the interdisciplinary exploration of Native American archaeoastronomy at that American Association for the Advancement of



FIGURE 8.13. *Maya Dresden Codex 46* (sections *b* and *c*, right) with images of God *L* as a *Venus Morning Star* warrior/sacrificer (top) and God *K* as his victim, pierced with a dart (below). God *L*'s name glyph appears in the upper text (first column, second row) with God *K*'s name below. God *L*'s body is painted blue, a color associated with sacrifice; his face is black; and his right arm, holding an *atlatl* (dart-thrower), has a red-painted wristlet with two blue beads or ties. (Förstemann 1880, 46; public domain; see Förstemann [1901, 1906] for commentary.)

Science (AAAS) annual meeting, organized together with its counterpart, the Mexican Consejo Nacional de Ciencia y Tecnología (CONACYT), and I had the privilege of being there. As a young graduate student in radio and extragalactic astronomy interested almost exclusively in the hard physical sciences, this was the first of many trips “south of the border.” I was enthralled by what I experienced there in and around the sacred landscapes of the Valley of Mexico at what had been the heart of the Aztec civilization, Tenochtitlan, and would never see the world quite the same way again. Tony was already turning his career away from mainstream astronomy, and I would soon do

the same. Travels with Tony's Colgate "January semester" student groups to Mexico would lead, in the immortal words of Yogi Berra, to one of those forks in the road that one comes to . . . and takes (Berra and Kaplan 2001). All of us gathered in 2012 at the completion of a great 5,125-year Maya long count cycle to honor Tony, including our two able Society for American Archaeology (SAA) session organizers and editors, archaeologist Anne Dowd (his former Colgate student) and Precolumbian art historian Susan Milbrath, would have taken entirely different paths in career and life if we had not met Tony on the road. My heartfelt thanks goes to all three for their invitation to be part of this much deserved *homenaje* for Tony Aveni, who is so many things: a gifted teacher, engaging writer, creative field trip leader, interdisciplinary researcher, and, of course, pioneering archaeoastronomer. There are so many stories one could tell . . . like the time we were out there in the overgrown jungle at the Maya site of Yaxhá in the Guatemalan Petén, and I asked Tony if it was alright for me to climb to the top of the great unexcavated pyramid mound (Structure 216) and give a shout-out with all I had. I enjoy it when he tells this story about me asking in advance for his permission, as it was just my quirky sense of humor.

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FLORA SIMMONS CLANCY

Today and anciently, the Maya Moon is accused of being erratic and erotic. She is a young woman; she is an old woman; she becomes masculine when she is full. She is visible, and then invisible. She is the patron of midwives, weavers, and suicides. She rules the night as the Sun rules the day but she insists on showing up during his day. The Sun, however, can never share her nighttime realm and so believes she is unfaithful to him. They are an odd couple. When they argue, they literally eat each other up.

In this chapter I discuss the Maya Moon by looking at the moon's role in the ancient calendar, by stressing the moon's close associations with the planet Venus, by considering the glyptic statement called the Lunar Series, and by describing the intriguing material evidence that the ancient Maya left us concerning celestial events. Several scholars agree that the first Mesoamerican calendars to be formulated were lunar in structure (Rice 2007, 37, 71), and Neuenschwander (1978) and Macri (2005) are quite explicit about a lunar basis for calendrical thinking. Except for sunrise and sunset, the sun is difficult to observe by eye; most observations of the sun involve the shadows it makes. Observations of the moon are more direct and immediate, and its cycles are patently obvious in the night sky. It is quite possible to argue that lunar calendars arose during Archaic period (3500–2000 B.C.) and Paleoindian (11000–3500 B.C.) times when folk were hunting and gathering, with mobile groups following

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herds and seasons (Marshack 1972; Nilsson 1920, 148; Rice 2007, 188–89). Night skies allow for good accuracy in predicting how to move across great distances (Farrar 2001). It follows then that the most widespread calendar in Mesoamerica, the 260-day calendar (or the sacred round, or, for the Classic Maya, the *tzolkin*), is thought to be lunar in its origins (Macri 2005; Rice 2007, 37, 71). While it may be lunar in origin, however, the *tzolkin* is also allied to the sun and the *haab* of 365 days, as well as with many other natural cycles perceived by the Maya. As Aveni (2001, 205) observes, ancient astronomers worked “to establish an order to human existence by bringing the naturally occurring astronomical cycles into accord with the 260-day calendar,” and, I would add, therefore into the cycles of the moon.

Preindustrial skies were quite different from the skies we know today, and a careful observer could have seen Venus during the day and even note that Venus had phases like the moon. Venus and the moon were closely linked in ancient Maya thought. John Justeson (1989, 94, 95), citing Teeple (1930), considers the ancient connections made between the Venus stations and lunar months was the origin for the approximate, but canonical, Venusian intervals given in the Venus tables of the Dresden Codex (Aveni 1979, 278; Lounsbury 1978; Milbrath 1999, 166). Anthony Aveni (1994, 15) aptly describes this as “Venus marching to a lunar beat.” John Burgess (1991, 63) notes that the interval from the moon’s conjunction with Venus, after that planet emerged from superior conjunction, to another moon/Venus conjunction after Venus emerged from inferior conjunction, averages 260 days, and indeed, he suggests that the *tzolkin* of 260 days may owe its origin to this lunar/Venusian duration. Lunar and Venusian associations are also found for the agricultural cycles of maize (Milbrath 1999). Wendy Ashmore (1991, 212) suggests a dualistic relationship between the moon and Venus, whereby the moon is associated with the female, the direction north, and with birth, while in dualistic opposition Venus is associated with the male, the direction south, and with rebirth.

So there is little doubt that Venus and the moon were anciently thought of as somehow closely aligned, but I have found little clarity about why it was important to the Maya or how the alliance between the moon and Venus was actually understood by the Maya. This is nicely illustrated by the several identities given by scholars to the Hero Twins of the *Popol Vuh*. Hunahpu is usually identified with the Sun, but also as Venus as Morning Star (Aveni 1994, 65). Xbalanque is the Moon, or the full Moon, or possibly Venus paired with the Sun. Hunahpu and Xbalanque have been variously interpreted as the Sun and Venus in the underworld or the Sun and Moon in the sky above the world (Ashmore 1991, 226n9; Aveni 1994, 68; Rice 2007, 68).

It is commonly assumed the main reason the ancient Maya astronomers kept track of the moon's movements and phases was to predict eclipses (Aveni 2001, 206; Bricker and Bricker 2011, 50).¹ Therefore any study of the moon in ancient Maya thought has been almost exclusively achieved by examining the lunar tables given in the Dresden Codex, a Maya book compiled around A.D. 1250 (Thompson 1972). These tables are surely concerned with accurately predicting eclipses, and they very likely contain auguries for certain lunar phases.

There is, however, another source of ancient Maya lunar data. Whenever a long count statement recorded a date, a rather lengthy passage devoted to the moon and its phases was often appended to it. This glyphic passage is referred to as the Lunar Series and, put together with the long count, makes up what is called an Initial Series date. The use of Initial Series dates spans the Classic period from the third to the ninth centuries, and they were commonly recorded on relief-carved monuments, especially the freestanding monuments we call stelae.² There exists, therefore, a large corpus of lunar notations that in my opinion have been understudied (but see Schele, Grube, and Fahsen 1992; Teeple 1930, [1928] 2001; Thompson 1960, 237–44).

THE LUNAR SERIES

An Initial Series statement begins with an Introductory Glyph, *tzik ab'*, “count of years,” which is infix with a variable glyph indicating the name of the deity who “rules” the month that will be reached by the ensuing long count (figure 9.1). Since the whole Initial Series statement ends with a glyph for the month, it can be compared to the manner in which Mayan stories or narratives are often structured, by telling the end of the story at its beginning, a narrative trope called telegraphing: “This is how rabbit lost his tail . . .” (Tedlock and Tedlock 1985, 134, 140). That the recording of time is structured as a story or narrative seems telling because it reveals an oral reality behind, or inspired by, time’s durations. Furthermore, it is logical since time was constructed as cyclical and because glyphic texts were framed within time’s cyclic durations. The Initial Series begins: “This is how the month, say Pop, comes to be.”

What follows the Introductory Glyph is the long count, a series of time cycles expressing the number of days that have passed since the beginning of time, or the creation of this world on August 11 or 13, 3112 B.C. The present day reached by these long cycles of time follows immediately. The month position of this day, however, does not follow as one might expect. What follows is the Lunar Series, and only after it is expressed will the month position be given to end the Initial Series statement.



FIGURE 9.1. *Piedras Negras, Stela 36, the Initial Series and its parts* (drawing by John Montgomery, © 2001, all rights reserved).

The Lunar Series is placed between the glyph that denotes the day and the glyph that denotes the month, thus splitting the so-called calendar round. I find this intriguing. One way of understanding this split is to suggest that the Initial Series is composed so that the day, or *k'in*, is linked to the long count and is solar in meaning (Rice 2007, 33). That, of course, is suggested by its name, *k'in*, Sun or day. The month, then, would be linked to the Lunar Series. Merideth Paxton (2001, 53–54), however, might disagree, because she understands the Lunar Series to be an “amplification” (Paxton 2001, 196n17) of the day or *k'in* glyph that with its affixed number represents the 260-day cycle of the *tzolkin*, while the month glyph and its number represents the *haab*, or solar year (Vague year) of 365 days. I have not been able to decide which view is correct and therefore wonder about, but cannot yet solve, the ambiguities created by the placement of the Lunar Series within a calendar round.

Here I will note that the glyphs inserted between the day and the month are now called the Lunar Series rather than the Supplemental Series, which some scholars believe is a better term because along with the obvious lunar notations there are two glyphs denoting a 9-night or 9-day cycle (Glyphs G and F,

see below) and, occasionally, glyphs recording a 7-day cycle (Glyphs X and Y, see below) (Yasugi and Saito 1991). Martha Macri (2005), however, convincingly argues that both the 9- and 7-day cycles are actually lunar in their origins. Bricker and Bricker (2011, 75) state that the use of the phrase Supplemental Series is the “old way” while Lunar Series is the “new way” of denoting these glyphs inserted into the long count.

The Lunar Series is a statement that describes in detail the position of the moon on the day arrived at by the long count. While epigraphers have made tremendous advances in the translation of Maya glyphs, they are still vague about translating the glyphs that make up the Lunar Series (Coe and Van Stone 2001; Montgomery 2002; Schele, Grube, and Fahsen 1992). John Teeple (1930, [1928] 2001) mainly worked out during the early decades of the last century what we know about the Lunar Series. Sylvanus Morley (1916) also made a major study of the Lunar Series and gave its glyphs lettered labels that unfortunately run backward so that G designates the first glyph of the series and A labels the last. Morley (1916) also added a Glyph X, a variable that sometimes occurs with Glyphs C. In 1938 E. Wyllis Andrews IV (1938) detected two glyphs that sometimes are included in the series and labeled them Y and Z, preserving Morley’s backward series. If an entire Lunar Series were present, it would consist of glyphs G F Z Y E D C X B A (Schele, Grube, and Fahsen 1992, 2).

As it is now understood, the first glyph of the Lunar Series describes a continuous 9-night or 9-day cycle (Glyph G, figure 9.1, glyph 1), described as the “Nine Lords of the Night” by Thompson (1960, 208) or as the nine Headdresses by Schele and colleagues (1992, 2), with a separate glyph for each lord or headdress. There is a mathematical relationship between the month and day glyphs of the long count and which lord or headdress appears (Montgomery 2002, 93). The next glyph (Glyph F, figure 9.1, glyph 2) is a verbal qualifier that describes an action taken by the lord or to the headdress—he “ruled the night” or “the headdress was tied,” suggesting a similarity to how upon accession to power an actual ruler had his or her headdress tied. Following this statement are one or two numbered glyphs (Glyphs E and D, figure 9.1, glyph 3) that show how old the moon is on the particular date given in the long count. In our example, Glyph E states, “it is the 4th night since the new moon.” If the number of nights since the new moon are 20 or over, then Glyph D, a Moon sign standing for 20, is appended to Glyph E. Actually, as Coe and Van Stone (2001, 51) point out, this phrase reads something like “it arrived” the 4th night of this moon. Stephen Houston (2012) compares the idea of the lunar “arrival” to the stately arrival of kings

and queens recorded at certain cities, which iterates the suggestion of royal metaphors for the phases of the moon.

Different cities had different calculations for when the moon was “new.” Most likely it was “new” when first visible on the western horizon. Given topography and longitude, people in ancient cities could see the new moon on different days. There are other points that may have been used to determine when the moon was new, such as from conjunction or from full moon to full moon, although Thompson (1960, 236–37) considered this last possibility unlikely.

The next glyph (Glyph C, figure 9.1, glyph 4) states its number and where the moon is within a six-moon cycle. In our example, “it is the 4th Moon in the 6-Moon series.” This 6-Moon series equals 177 nights ($29.5 \times 6 = 177$), and surely this is information having to do with eclipse cycles, but as far as I know, no actual eclipse was ever recorded on Classic Maya stelae (but see Milbrath 1999, 115–16). While this 6-Moon series, or 177 nights, is important in the lunar tables of the Postclassic codices, such as the Dresden Codex, Bricker and Bricker (2011, 53, 75) point out that there is no evidence of a Lunar Series in the codices. Glyph C consists of a flat hand with a numbered prefix signaling the number of the moon. The hand supports either a male head with jaguar ears, a female head, or a skull (Schele, Grube, and Fahsen 1992, 5). The assigned number may vary from city to city, however, because some moons were recorded as elapsed moons while others were recorded as the current moon (Schele, Grube, and Fahsen 1992, 5). Montgomery (2002, 96) noticed that an eye is also held in the flat hand and this is what our example displays (figure 9.1, glyph 4). The next glyph (Glyph X, figure 9.1, glyph 5) is thought to name the lunar month in the 6-Moon series. As expected, there are six name-glyphs, and Glyph C determines the number of the moon. Montgomery (2002, 96) suggests that the varying affixes attached to Glyph X may specify certain qualities of the moon. The next glyph (Glyph B, not included in figure 9.1) stresses that Glyph X is the name of the moon. Its translation is either X “is its holy name” or “is its youthful name.” These are descriptions often used for rulers and young heirs to rulership.

The last glyph (Glyph A, figure 9.1, glyph 6) states whether this particular moon was tracked as a 30-day or 29-day moon (alternating to approximate the 29.5-day interval recognized by the Maya). In our example, it was a 29-day moon (figure 9.1, glyph 6). Schele and colleagues (Schele, Grube, and Fahsen 1992, 7) believe that Glyph A is a noun and that Glyphs X and B form a dedication statement. So they would translate the meaning of Glyph A as “the [youthful] name of the twenty-nine.” Barbara MacLeod (1993, 3)

translates Glyph A as *patil*, meaning “and then” or “what comes last is” . . . a 29- or 30-day month.

Certainly more work is needed to create a fuller understanding of the Lunar Series, but it is interesting that there are clear metaphoric allusions to the actions and events of earthly rulers in the descriptions of the moon’s position within the cosmos. That this information should be so detailed in its particulars suggests a long history of lunar observations and deep concerns about the phases of the moon.

Two stelae from Piedras Negras, Stelae 1 and 3, inspired me to look into ancient representations of the moon and the Lunar Series (figure 9.2). Both stelae record the birth date of Lady K’atun, the protagonist of these monuments, as an Initial Series date. Of course, the long counts of these Initial Series are the same (9.12.2.0.16), but intriguingly, the Lunar Series are different. John Teeple’s ([1928] 2001, 254) explanation, accepted by Morley (1937–1938, 128, 147), for the difference is that Stela 1’s Lunar Series was calculated before the Period of Uniformity was fully established and Stela 3’s was calculated after.³ The Period of Uniformity, so named by Teeple, is a relatively short period of time, from A.D. 687 to 756 or 69 years, when several major cities must have come to an agreement as to how the (synodic) lunar and solar calendars would be commensurate with each other.⁴ Of course, neither Teeple nor Morley knew that dates recorded historical events, such as the birth of a queen, and many more monuments with Initial Series dates are known today beyond the corpus worked with by Teeple, so, as the introduction to the 2001 reprinting of Teeple’s 1928 article suggests, this “compels a reevaluation of this enigmatic period [of Uniformity]” (Houston, Chinchilla Mazariegos, and Stuart 2001, 242).

In 2005 I gave a short paper focused on these same two stelae, 1 and 3 from Piedras Negras, and their Lunar Series, an analysis I later included in my book on Piedras Negras monuments (Clancy 2009).⁵ I boldly titled it “Latitude Determines Where, Longitude Determines When: The Maya Lunar Series.” Fortunately, Christopher Powell, also attending this meeting, had a program in his computer that showed that longitude (along with topography) did indeed determine at what time and on what evening one might first see the moon rise after conjunction, a key sighting for the Lunar Series. I admit this did not turn my rank speculation into hypothesis, but it was intriguing enough for me to wonder if the two different Lunar Series given on Stelae 1 and 3 might record the position of the moon at Piedras Negras and its position at a place important to Lady K’atun, perhaps her hometown (Clancy 2009, 88).⁶

Piedras Negras, Stela 3, Back



Piedras Negras, Stela 1,
Front



FIGURE 9.2. *Piedras Negras, Stelae 1 and 3, with their Lunar Series picked out (drawings by John Montgomery, © 1998, all rights reserved).*

TABLE 9.1. Examples of Lunar Crescents Carved on Classic Period Monuments

Date	Site	Context of Lunar Image
9.4.0.0.0	Tikal, Pedestal 3	as frame
Early Classic	Hun Nal Ye Cave	held by female? with rabbit
ca. 9.16.0.0.0	Quiriguá Monument 18	half-framing seated male figure
9.18.0.0.0	Yaxchilán Stela 4	framing female ancestor in supernal panel
Late Classic	Yaxchilán Panel (in private collection)	framing female holding bundle
Late Classic	Chico Zapote Panel 2	framing female holding rabbit
Late Classic	Bonampak Sculptured Stone 2	framing War God holding rabbit
9.5.0.0.0	Caracol Stela 16	possibly as semicircle in headdress?
9.12.0.0.0	Yaxchilán Stela 6	possibly in supernal panel?

LUNAR ICONOGRAPHY

Lunar imagery is related to Venus in some Classic period monuments. I have gone through the corpus of Maya monuments looking for iconographic imagery representing the moon or Venus. There are very few obvious lunar or Venusian icons (Milbrath 1999, 211–214). I want to be clear here; I am talking about images, not glyphs. The star glyph, T510, or *ek*, however, is often understood as standing for Venus, and it can appear as an iconic element of costuming, especially in the headdress (figure 9.3). Whether it denotes Venus or holds the more general meaning of star (or both; see Houston and Martin 2012) has not been determined. The lunar crescent definitely occurs only six times as an image on monuments during the Classic period, but with a large geographic and temporal spread within the Maya region (table 9.1). The supernal images found on many Yaxchilán stelae show a pair of small figures, considered ancestors, within quatrefoil frames. On Stela 4, however, while a male sits within a quatrefoil, the female sits within a lunar crescent (figure 9.4). Since the quatrefoil is similar to some examples of the star or Venus glyph, this suggests there is either a meaningful distinction being made between quatrefoil and crescent or there is some sort of equivalence being made between moon and Venus.

Susan Milbrath (1999, 124–26, 155), analyzing Colonial and Postclassic imagery, Classic period monuments, and ethnographic information, concludes that the Water-lily Jaguar and the Jaguar God of the Underworld (which she calls the War Jaguar) are lunar creatures, and she also notes that the representation of the netted bead costume, associated with the maize deity and royal females, has a lunar significance. These icons are much more apparent within the corpus

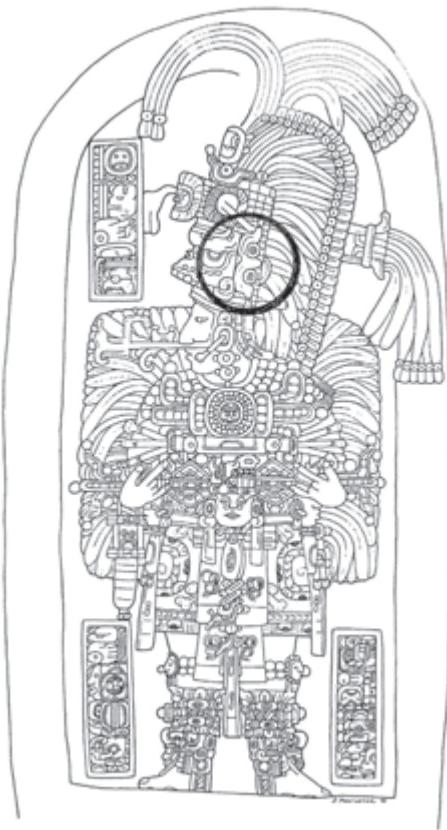


FIGURE 9.3. *Tikal, Stela 16 with the ek glyph in headdress circled* (drawing by John Montgomery, © 1995, all rights reserved).

of Maya monuments, but only one monument, Bonampak, Sculptured Stone 2, clearly shows War Jaguar traits linked with the rabbit and lunar crescent (figure 9.5). Similarly, the netted bead costume and the Water-lily Jaguar, as they are represented on monuments, have no certain connections with lunar iconography, such as the lunar rabbit or the lunar crescent. I am not claiming that lunar meanings were not inherent to these deities; given Milbrath's (1999) careful research, lunar meanings may well be part of their messages. What I do claim is a parallel to Justeson's (1989, 105) statement that "the extent to which phases of the Moon may have structured the recorded activities of the Maya elite remains unknown," and so similarly, there is little imagery on Classic monuments that clearly targets the importance of the moon in ancient Maya thought, and the same can be said for Classic imagery (not glyphs) clearly denoting Venus.



FIGURE 9.4. Yaxchilán, Stela 4, lunar crescent in supernal image (drawing by author after Maler 1903, plate 70).

The rabbit, which is sometimes associated with the lunar crescent, is the image modern Mesoamericans see on the face of the moon rather than the “man in the moon” in Western culture; nonetheless, it is generally thought to be an ancient lunar icon (Coe 1975, 15–16).⁷ Rabbits have been described as a twin to the deer with whom they are occasionally conflated, perhaps because both share large ears, split upper lips, and similar scat (Schele and Miller 1983, 46), and I would add that both animals are prey and not predators. The deer is associated with the sun (Schele and Miller 1983, 46; Milbrath 1999, 76) and with the planet Mars (Milbrath 1999, 222–23) while the rabbit is definitely lunar. Images of rabbits are more commonly found depicted on portable objects such as small clay sculptures or painted on ceramic pots than carved on monuments. This suggests their role as creatures in certain narratives and stories that do not have any particular iconic role in the representations of rulership common to stelae. It is an intriguing contrast; creatures important to the regal subjects carved on monuments are predators, jaguars, snakes, and caimans, and while these creatures certainly inhabit the imagery of portable works of art, their prey, rabbits and deer, seldom appear carved on monuments.

Looking through the six volumes of Justin Kerr’s (1989–2000) *The Maya Vase Book*, it seems obvious that rabbit had roles in other stories besides lunar ones. Nonetheless, when the rabbit is shown with a woman she is automatically considered a Moon goddess, and in Kerr’s corpus of Maya vases, the



FIGURE 9.5. Bonampak,
*Sculptured Stone 2, lunar
crescent, “War Jaguar,” and rabbit*
(drawing by author after Schele
and Miller 1983, fig. 18c).

rabbit and woman occur together only eight times (Kerr numbers 559, 796, 1398, 1491, 2733, 3462 [this rabbit looks funny], 5166, and 5359). The rabbit and woman pair is illustrated in several portable media, however, and certainly the small Jaina-style clay sculpture of a woman and a grinning rabbit in an amorous embrace is evocative and hints at a ribald story that matches many of the modern ethnographic stories about the moon (Schele 1997, plate 35).

Almost any woman depicted on painted vases, however, seems to have the potential to be a Moon goddess who can be young or old, depending on which phase of the moon is being represented. This very general association of the female with the moon probably extends to other media as well. Karl Taube (1992), refining and expanding Paul Schellhas's (1904) letter designations for Postclassic gods, demonstrates how Goddess I is the young Moon goddess as well as, occasionally, merging with the tonsured maize god (Taube 1992, 69), while Goddess O is the old Moon goddess (Milbrath 1999, 147). This fits with the idea that the waxing moon is the young goddess, the full moon is male, and the waning moon is the old goddess (Milbrath 1999, 135, 140, 147).

Most of our knowledge about the moon, or any celestial body, is arrived at by ethnographic analogy. In Thompson's (1939, 1960, 1970) discussions based on extensive ethnographic research about the moon in modern Mayan thought, he ultimately characterizes her as an intriguing and wanton woman. Based on the same material, today she would be considered an independent character that chooses her own partners and controls her own destiny.

CONCLUDING REMARKS

Our best authentic knowledge of ancient celestial concerns comes from the codices, such as the Dresden Codex, and then glyphs, such as the Lunar Series. Another important source is the material evidence of architectural orientations. Architectural orientations to the moon, however, have been little studied with the exception of the work of Alonso Mendez and colleagues (2008) at Palenque and lunar orientations proposed for structures at Paalmul and Edzná (Milbrath 1999, 116). Solar orientations are best known, or studied, starting with the very early and common Group E architectural complexes that may iterate the sun's journey either through 20-day intervals or solstices, equinoxes, and zenith passages (Aveni, Dowd, and Vining 2003; Estrada-Belli 2011, 78–79). Venusian orientations are best documented for the architecture of Late Classic (A.D. 600–900) and Postclassic (A.D. 900–1519), northern Yucatán, such as the Governor's Palace at Uxmal and the Caracol of Chichén Itzá (Aveni 2001).

Of course, there is the debate about the windows of the Caracol at Chichén Itzá—whether they are oriented toward the maximum standstills of the moon (Hawkins 1973, 184–85; Ricketson 1928; Sharer and Traxler 2006, 564) or the extreme declinations of Venus (Aveni 2001, 276; Milbrath 1999, 158). Actually, it should not be necessary to have to choose between either the moon or Venus in this case (and this is important) because the azimuths of the lunar and Venusian extremes are within 2° of each other; the ancient Maya were surely aware of this, and this correspondence was surely important to their cosmology.⁸

There is existing evidence that the ancient Maya also observed the sidereal cycles of Venus (Milbrath 1999, 209–11) and the moon, especially the moon's three-month sidereal period of 82 days (Barthel 1951; Dutting and Schramm 1988; B. Tedlock 1992). Certainly, the horizon-based, synodic cycles of the moon and Venus were important for the astronomers who composed the lunar and Venusian tables as they are recorded in the Dresden Codex, but as far as I know, there has yet to be any careful research on the ancient observation of sidereal cycles and their durations, except for work by Aveni and his colleagues (Aveni, Bricker, and Bricker 2003). One thing to note is that at 18° latitude, the number of days between the zenith passages of the sun moving north to south is 82 (May 11 to August 1), that is, the duration of three sidereal lunar months. The 18° latitude division runs very close to El Mirador and Calakmul and, indeed, to Olmec La Venta.⁹

Although the role of Venus in the ancient Maya mind has received a fair amount of scholarly attention, the ancient Maya Moon, for unknown reasons, has not (Coe 1975, 18; Mendez et al. 2008, 310). It is mostly known through

modern ethnographic enquiry and the Postclassic lunar tables given in the codices. Yet if the hundreds of Lunar Series statements embedded within Initial Series dates are any indication, the moon must have played a much greater role in the ancient Maya's thinking about the cosmos than has heretofore been acknowledged. The moon's connections with Venus have been noted and commented on, but the important correspondence of their extreme azimuth positions on the eastern and western horizons does not seem to have received much attention other than in footnotes or asides. The curious lack of obvious lunar icons displayed on monumental sculptures, and this goes for Venusian imagery as well, may be explained by the fact that the important durations measured by these celestial bodies were understood as, or explained through, narratives or stories, and narratives are seldom the subject matter of Classic period relief-carved monuments that are dedicated instead to regal display.

NOTES

1. In Bricker and Bricker's (2011) monumental work, *Astronomy in the Maya Codices*, chapter 9 is devoted to the lunar table of the Dresden Codex (they call it an Eclipse Table).
2. The use of the long count alone dates much farther back in time.
3. Morley (1937–1938, 147) claims that the long count date of Stela 1, 9.12.2.0.16, is the “official beginning of the Uniform Lunar Calendar, although this calendar was not actually used on a monument until 13 years after this date.”
4. Justeson (1989, 87) points out that the system employed during the Period of Uniformity to construct the Lunar/Solar commensurability was also used by several cities during the Early Classic period and that “The Uniform System was evidently in use throughout the Maya area from the beginning of the Early Classic.”
5. Presented at a seminar held by the Solstice Project, Santa Fe, New Mexico, 2005.
6. The “serpent segment” glyph, T566, in Thompson's (1962) *Catalogue of Maya Hieroglyphs* may represent Lady K'atun's hometown, which Martin and Grube (2008, 145) call Namaan. Because T566 often occurs in so-called skybands, Eric Simpson (1995, 586) believes it carries a more celestial meaning.
7. The Chinese believe a rabbit inhabits the moon, and Williams (1988, 221) considers the Chinese lunar rabbit traceable to India. Considering the antiquity of lunar calendars, the lunar rabbit may be ancient cultural baggage that traveled from the Old World to the New.
8. Gerald Hawkins (1973, 184–85) gives the azimuth of the lunar extremes, rounded off, as 29° and Milbrath (1999, 158) lists the Venusian extremes as 28° 53' north and 27° 49' south. See also Aveni (1975, 181, table 4) and Šprajc, this volume.

9. Peeler and Winter (1992, 40) suggest that during the Middle Preclassic period east/west was the orienting direction, not north/south, and town plans were best thought of as oriented 82/262 days rather than 8° west of north.

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*Pecked Circles and
Divining Boards**Calculating Instruments
in Ancient Mesoamerica*

Anthony Aveni (1999; Aveni, Hartung, and Buckingham 1978) has made a cogent case explaining the famous pecked circles at Teotihuacán in Mexico and a contemporary example from Structure A-5 at Uaxactún in Petén, Guatemala, as functions of their astronomical and calendar notational features. In an important further investigation of such features at Teotihuacán, Aveni (2005) studied a variety of pecked designs on the floor along the south side of the Pyramid of the Sun at Teotihuacán, following up studies by Rubén Morante López (1993, 1996, 1997a, 1997b). These pecked and incised designs illustrate a wide array of square as well as round patterns. Karl Taube (1999) has identified some of these patterns as representing cultivated land, which is further referenced by Aveni as perhaps symbolizing the earth (figure 10.1). We will shortly return to this particular design.

Aveni (2005) carefully tallied the numbered intervals as day counts in these designs at Teotihuacán and concluded that there is support for the hypothesis that they were used for counting seasons or agricultural cycles. He also considered the resemblance of some of these patterns to later game boards for quince or patolli. Such games could involve stick dice, as we discuss further below. We quote from Aveni's (2005, 43) conclusions:

One can well imagine the site as a place for calendrical divination of the type we see much later in the codices. There, specific offerings are shown being

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FIGURE 10.1. *Incised boards on south side of the Pyramid of the Sun* (photographs by Lorraine Aveni).

made to particular agrarian deities (rain, maize, sky, etc.) on carefully chosen dates that suited both the sacred 260-day and seasonal 360-day cycles. Making the count of the days and assessing them for good or bad luck in a tabular format could well have been part of the process one still finds in contemporary Mesoamerican divinatory practices . . . The foregoing conclusions do not imply that the game board hypothesis should be discarded . . . Casting lots, which is also part of the rules of quince, may have been connected with some sort of divinatory process involving agricultural prognostication via calendrical intervals.

Recently, Barbara Voorhies (2012) wrote about Archaic period (3500–2000 B.C.) pecked semicircles at the site of Tlacuachero that she suggests might

have been very early gaming boards like the quince boards used by modern Tarahumares. She noted in the same article that games like patolli were played throughout Mesoamerica, often with tokens and stick dice among other instruments. Gaming boards incised into surfaces of plaster and stone are well known in the Prehispanic Maya archaeological record.

We have recently begun to study objects in the shape of tokens and sticks discovered in Classic period (A.D. 200–900) Maya contexts, and believe stick bundles might signal the practice of divination with stick dice. Karl Taube (2004) has made good case for stick bundles registering fire ceremonies. But the association of stick bundles with calendar events may involve divination as much as fire. As Taube (1999) noted in his article on Teotihuacán writing, the lord on El Chayal Monument 1 is casting onto the table, not into the censer. This is likely an act of casting lots for divining. Other examples illustrating sticks include courtiers holding sticks in front of objects that appear to be mirrors in Late Classic (A.D. 600–900) Maya vase art, for example, Kerr vessel K8793 (accessible online at the Maya Vase Database [<http://research.mayavase.com/kerrmaya.html>]). While sometimes these objects might be construed as writing instruments (Coe and Kerr 1998), in other cases multiple individuals are holding sticks, and they are far from any possible writing surfaces suggesting other functions (e.g., K6437 and see McAnany 2010, 284–85, for a discussion of the Fenton Vase). Sometimes individuals wear what could be bundles of sticks in their headdresses (e.g., K1728). In other instances, there are bundles of sticks in offering vessels (e.g., K1790).

In 2006 Michelle Rich and her colleagues (Rich et al. 2007; Rich et al. 2010; Rich 2008, 2011) discovered a royal burial in Structure O14-04 at El Perú-Waka' in northwestern Petén in which artifacts comprising the mortuary assemblage are relevant to this question of stick bundles and divining boards. Designated Burial 39, the vaulted masonry tomb chamber contained the remains of an adult ruler laid out in majesty, accompanied by a sacrificed child and many offerings. The intrusive chamber is located underneath the floor of the shrine atop the frontal platform (*adosada*) appended to the stairway of the pyramid. Dating to the mid-seventh century, Burial 39 is one of three interments discovered within the frontal platform. The other two burials date to the late fourth century and are more closely related temporally to the construction of the *adosada* in the Early Classic period (A.D. 200–600).

A unique narrative scene of twenty-three ceramic figurines was placed at the feet of the ruler in Burial 39 and evidently represents one phase of the funeral rituals for this ruler (Freidel et al. 2010; Rich and Freidel 2010). The ritual performers portrayed in the scene include a seated singing shaman,

dwarves, a hunchback, and a frog. A presiding king and queen, courtiers, and the dead king as a kneeling penitent being prayed over by a deer *way* spirit are also represented. In the context of this chapter, we focus on the presiding queen. She holds a small object in her right hand that resembles the little fans or cloth scepters carried by kings of Copán on Altar Q (see Stuart 2004), and on her left arm she wears a round shield. Similarly, on El Perú Stela 34 (see Guenter 2005) Lady K'abel also wears a round shield on her left arm. Lady K'abel, or Lady Water Lily Hand, was a Snake dynasty princess (K'uhul Kaan ajaw) and presiding *kaloomte'* (supreme warrior) of Waka' during her reign in the latter half of the seventh century. She appears to have been representing her overlord and probable father, the Snake king Yuhknoom Ch'een the Great, of Calakmul.

This is not the only monumental portrayal of a female ruler with a shield on her arm at Waka'. In addition, the woman represented on El Perú Stela 31 also wears a round shield on her left arm. We do not know her name, but she was an eighth-century successor queen of Waka' and wife to King Bahlam Tz'am—a ruler who, in turn, was installed by the last Snake king of consequence: Yuhknoom Took K'awiil. In considering these examples, the figurine queen's shield is clearly symbolic of her military status, but it is more than that: where the Stela 31 queen's shield has a tassel attached, the figurine queen's shield has an object on it that is decidedly attached, pointing up. Careful inspection of the photographs taken during the conservation of the queen figurine demonstrates that this design was deliberate (figure 10.2). We posit that this object is a stick, possibly a writing instrument, but also possibly symbolic of stick dice used in divination and gaming.

The figurine queen's shield is distinctively decorated with painted lines (figure 10.3). These lines seem to form a design identified in the corpus of rectilinear boards incised on the floor adjacent to the south wall of the Pyramid of the Sun (Aveni 2005). This design motif was identified by Langley (1986) in his study of Teotihuacán symbols as possibly associated with the earth, and more firmly identified by Karl Taube (2000) as symbolic of tilled earth in his study of Teotihuacán writing. It is also possible, however, that the painted lines on this plate posing as a shield represent tesserae of iron pyrite on a mirror surface. Taube (1983) in his seminal study of the Teotihuacán Great Goddess, Spider Woman, on the Tepantitla mural there, suggests that she is closely associated with mirrors, both real mosaic ones and water mirrors in plates. Taube (1983) notes that mirrors could also be set into plates for purposes of divination. We will come back to this possibility shortly, but returning to the first prospect, in modern Maya ethnographic contexts, divining board surfaces, altars, or *mesas*

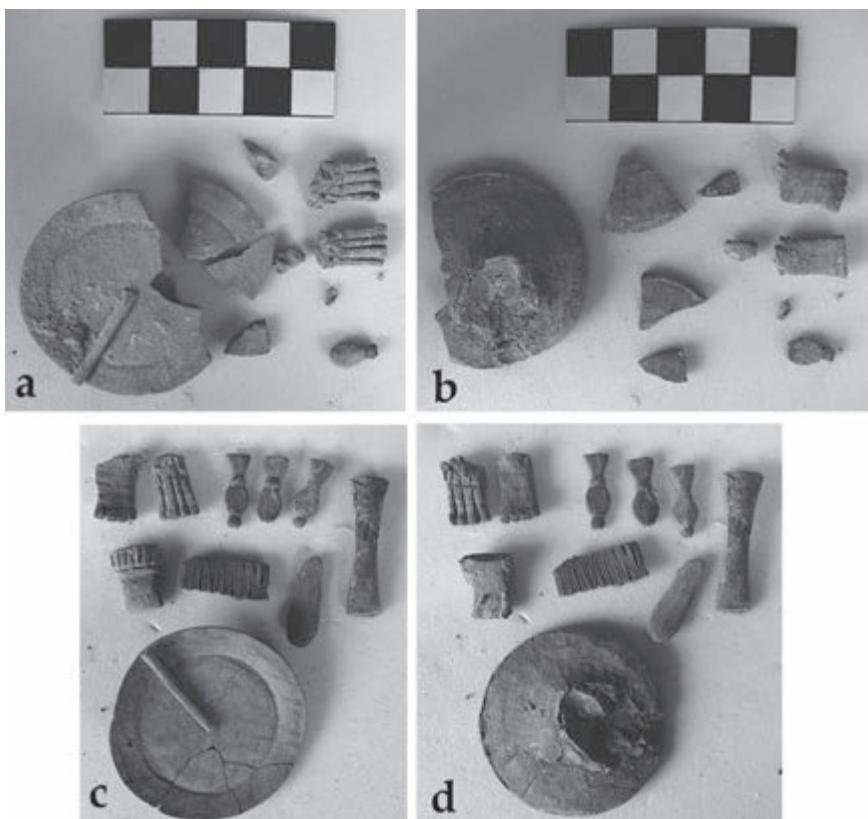


FIGURE 10.2. The figurine queen's shield and other small figurine adornments as seen during the conservation process (photographs by Griselda Pérez).

are often likened to milpa gardens or more broadly with the earth. Taube (2004), in his interpretation of the casting gesture of the lord on the El Chayal monument, notes this and sees the gesture as symbolic sowing of seed. In the case of the queen's shield, then, the stick might also be a symbolic digging stick. These possible metaphoric references on the plate-shield are not mutually exclusive.

The Burial 39 mortuary assemblage also contained several clusters of artifacts at the northern end of the tomb, arranged on the funerary bench above the head of the deceased. These may have been deposited in discrete bundles. Several miniature vessels and pigment concentrations were dispersed among these bundles; a large modified deer cowry shell (*Cypraea cervus*) was associated

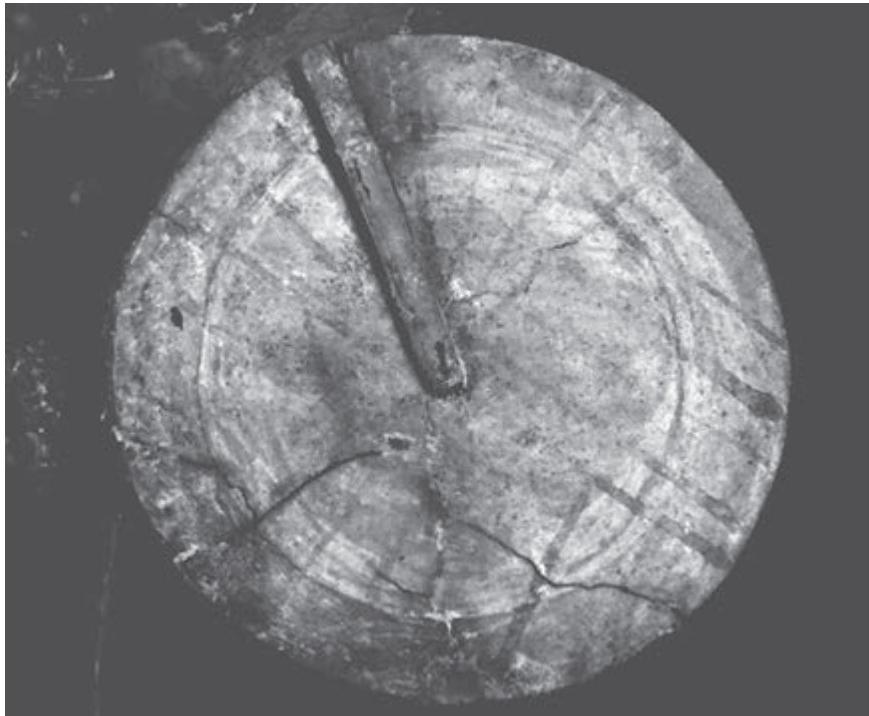


FIGURE 10.3. *The shield held by the queen figurine in the Burial 39 narrative figurine scene (photograph by Michelle Rich).*

with one of the groupings containing miniature spindle whorl tokens; an Olmec style heirloom serpentine figurine was featured in one of them, cached in between two plates (Rich et al. 2010); and a square pyrite mosaic mirror with ceramic backing was placed in another lip-to-lip cache vessel set. The concentration of sixty-four tiny elaborately carved spindle whorls was discovered at the north end of the bench (figure 10.4). While possibly functional, these whorls fall in the extreme low end of sizes documented in Maya contexts (Chase et al. 2008). Many of these tiny whorls appear to be white effigy flowers with delicate petals, and this suggests that they had symbolic connotations like the flowers and other precious items that are scattered from the hands of rulers in Classic stela depictions. These features lead us to postulate that they were not functional thread-making tools but rather were used for casting and divination. Two bone “needles” or “spatulas” were also part of this bundle. Together, these objects could also be identified as a weaver’s toolkit, which we are not

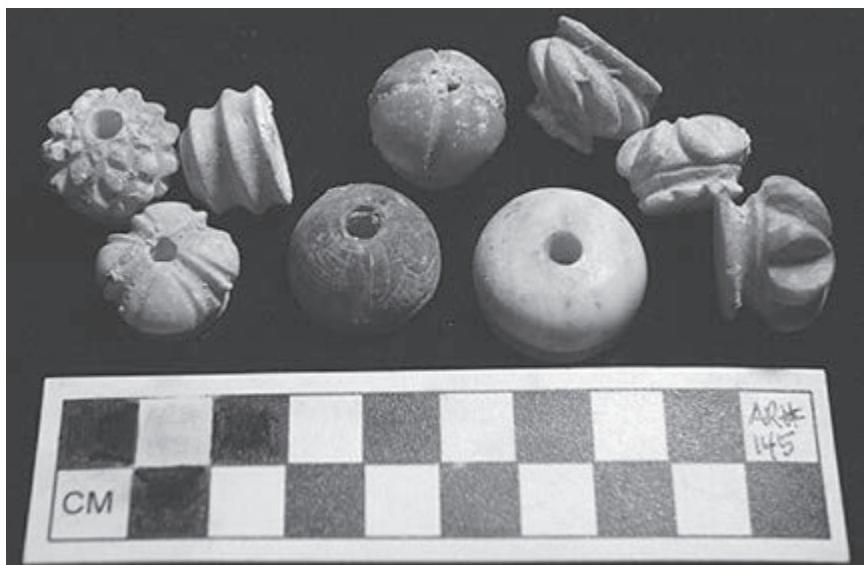


FIGURE 10.4. *A sample of spindle whorls from the Burial 39 mortuary assemblage (photograph by Michelle Rich).*

ruling out as an alternative—or even complementary—interpretation. While we hypothesize that this assemblage represents casting tokens, weaving accoutrements and divining tools do not have to be mutually exclusive. Given the large number of the spindle whorl-shaped artifacts, however, it seems likely to us that their main function was not as weaving tools and that this reference is metaphorical. The goddess Chak Chel was associated with weaving instruments, both in the Classic (A.D. 200–900) and Postclassic periods (A.D. 900–1519), and she was also the principal patroness of diviners.

Another potentially bundled component of the mortuary assemblage above the head of the deceased was a collection of delicate bone carvings in the shape of sticks, some of which had painted figures at each end. Small, stand-alone carved tokens were also identified within this bundle of sticks. These fragile and fragmentary bones have yet to be conserved, and the variety of carvings is in the process of being systematically documented and analyzed by Rich, but flowers, birds, seed pods or shells with masks in them, hands holding masks, feathers or brush tips are notable elements represented (figure 10.5a–b). Among the stand-alone tokens were miniature deity masks and winged creatures painted in polychrome colors. Located near this bone bundle was the small square mirror surfaced with pyrite crystal mosaic deposited inside two

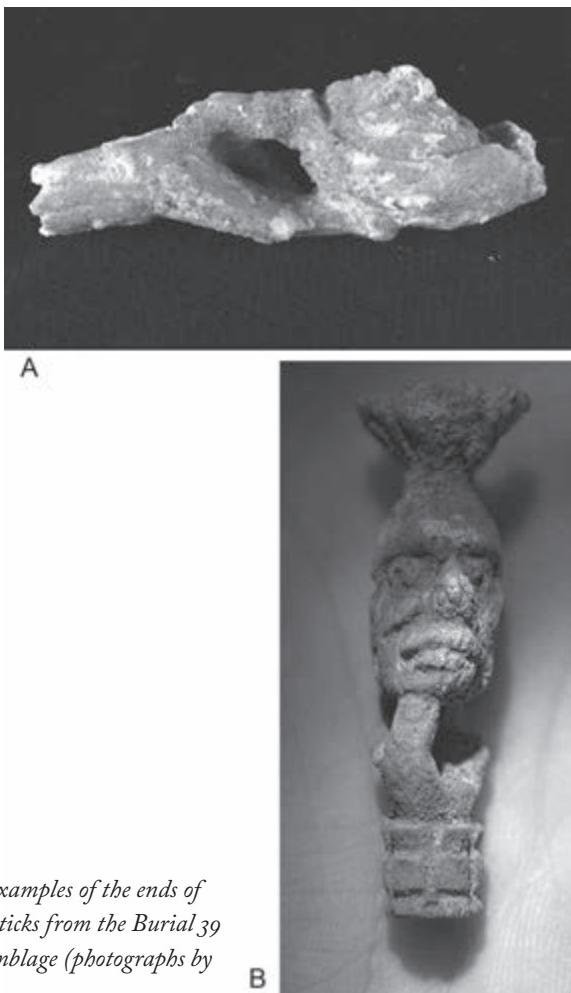


FIGURE 10.5. Examples of the ends of the carved bone sticks from the Burial 39 stick bundle assemblage (photographs by Michelle Rich).

lip-to-lip cache vessels. The figurine queen in the funeral assemblage at the foot of the deceased appears to wear two bundles of sticks in her headdress with red tops and black painted bands on them. In light of our proposal that she is carrying her divining or gaming board shield with its single stick, we hypothesize that she may have been responsible for divining at the funeral, and that the cluster of intricately carved bone sticks on the funerary bench indicates the deceased was similarly equipped for such divining in the afterlife.

Sticks with elaborately ornamented ends such as found in the stick bundle described above appear to function as “hat pins” in turbans worn by dignitaries

in Classic period vase scenes, but usually as single items or at most two or three. Coe and Kerr (1998) identified these as insignia in the headdresses of scribes. Justin Kerr (n.d., K8019a-d) has photographed a set of such sticks from a looted Classic tomb with distinctive faces on several of them. The faces have mouths with rounded lips singing or whistling. In the Burial 39 mortuary assemblage there is a seated shaman figure with the same rounded lip pose. At Copán the sixth-century Margarita tomb contained a remarkable concentration of materials that are worth comparing with the seventh-century Burial 39 tomb. We quote from Ellen Bell and her coauthors (Bell et al. 2004, 140): “The deposit included painted organic objects, two pyrite mirrors, *Oliva* shells, stingray spines, and a large concentration of objects that were probably woven or strung together. These small objects include shell rings carved with small faces, tabbed jade and shell rings, a worked bone spatula and awl, and needles, beads and bangles made of shell and jade. All of these objects seem to have been held by perishable containers, including netted, coiled or woven baskets, bags and painted gourds.”

While the rings might have been jewelry, their direct association with a dense concentration of bone needles and bangles such as found in Burial 39 bundle concentrations suggests to us that this is a functionally similar set of materials we are identifying as calculating and divination paraphernalia (figure 10.6). The presence of the mirrors enhances this comparison. Individually, such bone objects are usually identified as sewing needles, but in this context and in such numbers we think that the alternative of divining sticks is more plausible.

Ornamented sticks like those in Burial 39 are also depicted on the seventh-century murals of the Chiik Nahb Structure SubI-4 at Calakmul, Mexico (Martin 2013, fig. 40). In that scene a seated woman holds one stick in front of a bowl containing eight sticks placed vertically, as if they were stuck into a substance within the bowl. A man squats before her. A second man sitting behind the first man gestures over a bowl with five vertically placed sticks. Martin (2013) suggests that these are hairpins or weaving picks. We are here proposing a different function and note the association of these sticks with bowls. Just how these sticks might relate to the bowls is problematic. In the context of the Chiik Nahb murals they might be regarded as displayed for sale. But services are provided in the mural depictions as well as goods, as in drinks consumed there, so it is possible that what is being offered here is a divination. That would be commensurate with the gesture of the woman handling one of the sticks. How the position of the sticks in the bowls might relate to divination remains unclear, but evidently they were stuck into some substance thick enough to stand up.

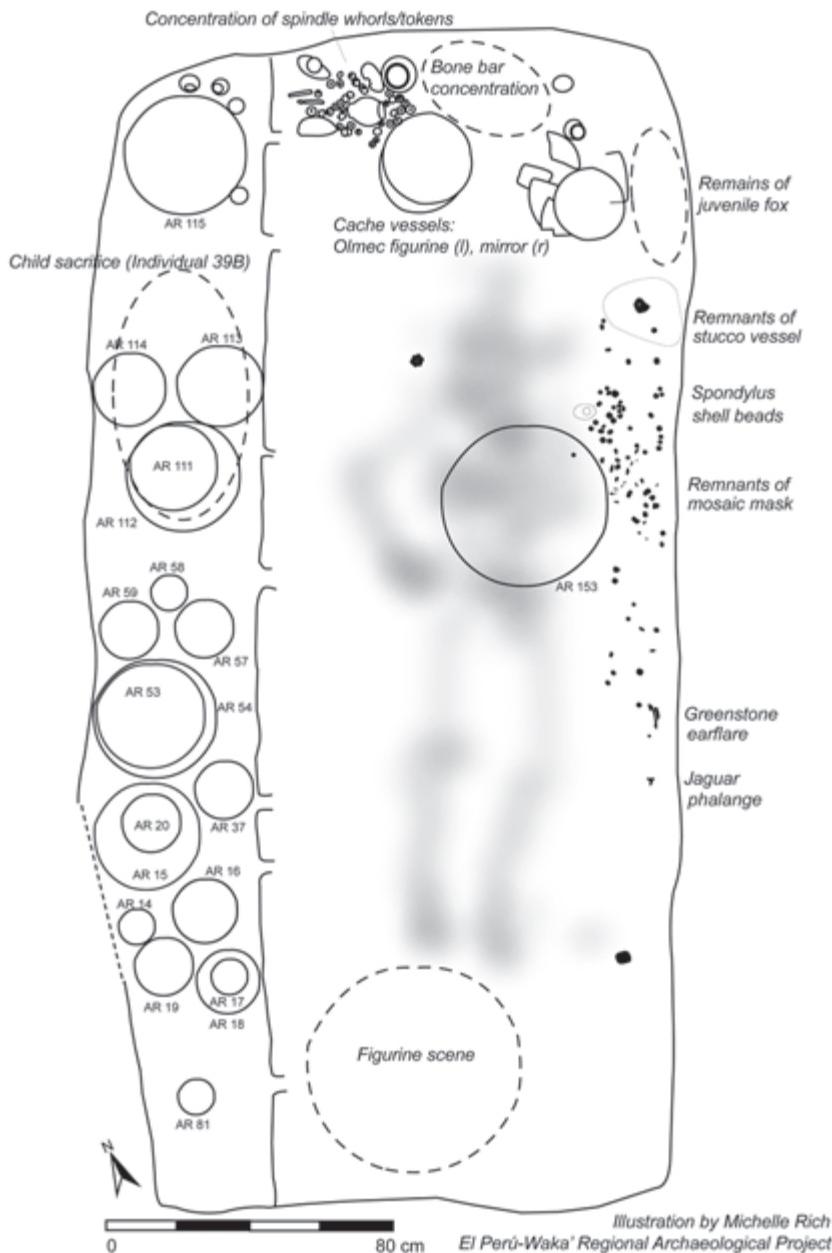


FIGURE 10.6. Preliminary plan of Burial 39 El Perú-Waka' with shaded image denoting general location of primary interment; all artifacts not included (drawing by Michelle Rich).

The small square mirror in one of the bundle bowls in the tomb also raises the possibility of divination. As Taube (1983) discusses, bowls of water were used as mirror surfaces for divination at Teotihuacán, and he observed that the dark mirror surfaces depicted in Classic Maya vase painted scenes seem to be set inside bowls or deep dishes. Those scenes also often depict individuals holding sticks and bearing ornamented sticks in their headdresses. He shows that in several mural scenes at Teotihuacán there are what appear to be mirrors set inside bowls or dishes, and he relates these to his discussion of the Spider Woman or Great Goddess deity depicted, in particular, on the Tepantitla mural. The square mirror is distinctive in that it is small and not round like other mirrors found in tombs at El Perú-Waka'. It is also the only one found inside a dish or bowl at the site (figure 10.7).

The square mirror in the burial bundle is surfaced with pyrite crystals. There are several participant figures in the figurine scene that carry sticks and rectangular boards painted golden yellow, the color of pyrite. The corpus of Classic period Maya vases includes a number of cases where they are decorated with rectangular fields ornamented with clusters of olive shell tokens. One (K7069) shows the shells forming the four-petal glyph for sun and day, *k'in*. This example shows the same design composed of shell tokens framing effigy pecked circles on golden fields, possibly representative of pyrite-surfaced round mirrors. The possible effigy pecked circles of course resemble the real ones discussed at length by Aveni (1999, 2005) and colleagues (Aveni, Hartung, and Buckingham 1978) in their research.

In another Classic period royal tomb at El Perú-Waka', Burial 37, Escobedo and Meléndez (2007) discovered a large round pyrite mirror with a scatter of *Spondylus* and jade tokens next to and underneath it. We have posited that these tokens, pierced for attachment, may represent the remains of a spangled turban such as worn by artists, sages, and diviners at Maya courts. More of these distinctive penny-size tokens were found scattered in Burial 39 next to the body, and in that case they were likely not associated with a cloth but were just placed there as an offering.

Clearly, there is a great deal more work to be done in the search for artifacts that may have served as counting and divining tokens and the surfaces on which they were arranged. In the case of Teotihuacán, the iconography of casting is well attested in the mural paintings of the city. What were the actual artifacts cast? One possibility we think might be worth exploring is the so-called *adornos*, mold-made ceramic items that come in a wide variety of forms (Sugiyama [2002] 2005). No doubt these were indeed used in the production of theater censers, but those censers are probably effigies of ancestor bundles,

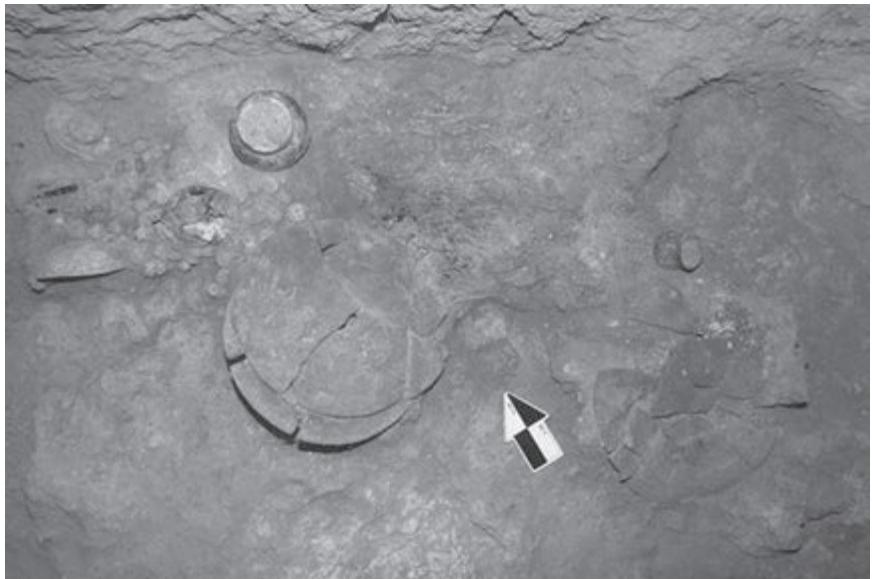


FIGURE 10.7. Artifact concentrations in Burial 39, with the square pyrite-surfaced mirror or divining board in two fragments below the miniature vase on the right, extruding from the flattened and broken ceramic plates of the rightmost lip-to-lip cache. The spindle whorls and modified cowrie shell are to the left of the frame (photograph by Michelle Rich).

and ancestors like the ruler in Burial 39 were equipped to be sources of prophecy through casting and divination. The tens of thousands of *adornos* found in the Ciudadela workshop were not actually on censers. Perhaps they were made primarily for divination with pecked and inscribed board surfaces such as those adjacent to the Pyramid of the Sun that Aveni discusses. As previously discussed, a small number of bone objects, “*adornos*,” were incorporated into the bone bundle found in Burial 39. These include polychrome images of winged creatures similar to the butterflies reported by Sugiyama from the Ciudadela excavations.

We are a long way from any final conclusions regarding the function of the carved bone sticks, spindle whorl tokens, and spangles discovered in elite tombs at El Perú-Waka’. As mentioned above, other remarkable concentrations of artifacts exist, and these comparable examples challenge us to search the archaeological record for new data. Again, the traditional functional identification of the sticks as weaving picks and needles makes sense of isolated examples but in our view is less satisfactory when explaining dense

concentrations of such artifacts. The famous scrimshawed bones of Burial 116 at Tikal (Moholy-Nagy and Coe 2008, 61–62) were concentrated as if in a container, according to the analysts, in what we would call a bundle. In shape and size they reminded the analysts of Chinese bamboo splint books. Bamboo splints are used for divination in China. Aveni's analysis of the Teotihuacán and Uaxactún pecked circles indicates that although these are not contextually associated with tokens, they were clearly used for counting and calculating, likely of days in the agricultural year. And in the Maya area, archaeologists are beginning to identify concentrations of other possible tokens, as in the small stone balls discovered in Late Preclassic period (400 B.C.–A.D. 200); context at Ceibal (Inomata, forthcoming). Those were placed in offering plates. In these types of interpretations, along with the present chapter, we have the beginning of a series of related patterns in artifacts that show promise of leading toward a better understanding of just how ancient Mesoamericans practiced divination in association with day counting and calendar calculations. These traditions are antecedent to their known practices in the Postconquest or Colonial period (A.D. 1519–1697) through Modern periods (A.D. 1950–present).

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*The “Las Bocas Mosaic”
and Mesoamerican
Astro-Calendrics*
“Calculator” or Hoax?

PRUDENCE M. RICE

A singular artifact sometimes known as the “Las Bocas ‘Mirror’” was purportedly excavated from a burial at the small “Olmec” (Middle Formative, 1000–400 B.C.) village site of Las Bocas in western Puebla, Mexico (figure 11.1). In the only published analysis of this pyrite mosaic plaque, Alexander Marshack (1977, 373) concluded that it “represents the symbolic [thirteen-month] lunar year, perhaps a particular lunar year in a solstitial or equinoctial and artificial year conjunction” and suggested a date of about 1000 B.C., based in part on its presumed origin from the Olmec site of Las Bocas. David Grove (personal communication, May 1, 2004), however, is highly skeptical of such an early date: the artifact was recovered from illicit excavations in 1963–1964, and there is no solid evidence that it is Olmec in origin, Formative in date, or even came from the Las Bocas site. In fact, Grove suggested that it might date to the Classic or Postclassic periods.¹

Mindful of this well-merited skepticism, I nonetheless think this object deserves greater consideration. As discussed below, the Las Bocas mosaic plaque can be shown to be a unique “calculator”-like device for numerous astro-calendrical computations and is either a one-of-a-kind cognitive tool or a remarkably complex hoax.

THE LAS BOCAS MOSAIC

Measuring 8 × 14 cm, the mosaic was created on a roughly rectangular ceramic base with beveled edges.

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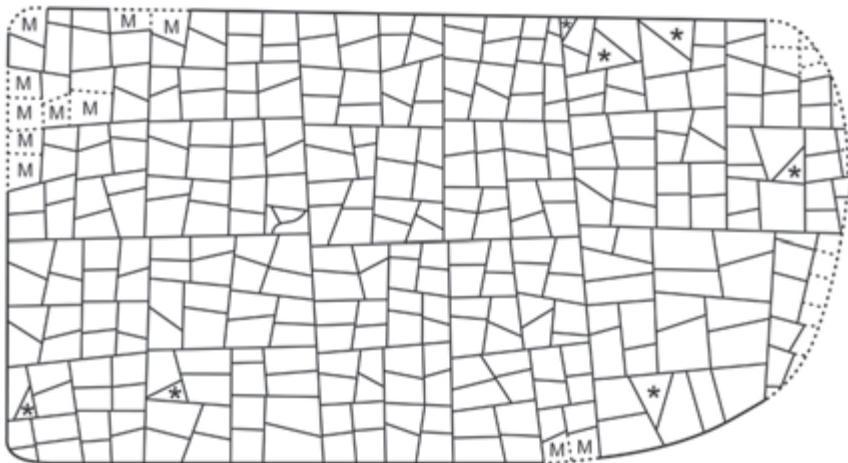


FIGURE 11.1. Layout of the pyrite tesserae of the *Las Bocas* mosaic plaque (redrawn with modifications from Marshack 1977, fig. 7). Dotted lines indicate missing polygons (M) and the right edge; asterisks (*) locate triangular pieces. Width: 8 cm; length: 14 cm.

The base was covered with a lime “cement” or plaster and overpainted with cinnabar (Marshack 1977, 347–48, 350, 352). Finally, more than 300 tiny, tightly fitted, polygonal tesserae or mosaic pieces of “highly polished yellow-silver pyrite” were set into the surface, and no two of the pieces are the same size or shape; they are of variable thickness (Marshack 1977, 342, 356).

The mosaic consists of three triptych-like panels, which are clearly apparent in the schematic published by Marshack (1977, fig. 11), here identified for descriptive purposes as Left, Center, and Right (figure 11.2). The Left and Center panels are virtually identical, with the tiny polygonal tesserae arranged in groups of four, which I call “standard base-4 units” or SBUs. I refer to the larger arrangements of SBUs as “pairs” of SBUs or 8 tesserae, “groups” of two pairs or 16 tesserae, and “blocks” of 32 (table 11.1). As Marshack (1977, 362) noted, “Four seemed to be the conceptual organizing frame. Four sets of 2 to make 8, four sets of 8 to make 32 and four sets of 32 to make 128.” Larger “squares” composed of two blocks hold 64 polygons (2×32), as do paired vertical “columns” or half-panels. In sum, the Left and Central panels each originally had 128 polygons, for a total of 256 (Marshack 1977, fig. 7).²

The Right panel differs substantially from the others (table 11.2). The right edge is curved, rather than rectangular, and the plaster matrix projects 2 mm beyond the edge of the underlying ceramic plaque. Marshack (1977, 352)

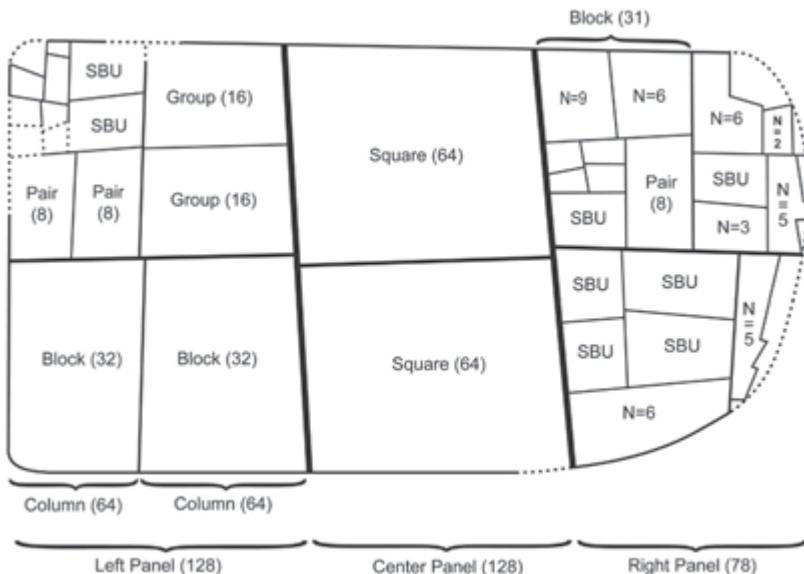


FIGURE 11.2. Proposed sequence of cutting the pyrite to create three panels, then successive subdivisions of the Left and Center panels to create squares, blocks, groups, and pairs, all composed of standard base-4 units (SBUs) (redrawn with modifications from Marshack 1977, fig. 7). The Right panel followed the first part of this sequence, but subdivisions created numerous variably sized “quasi-units” in addition to only 7 full SBUs remaining (additional SBUs would be part of Marshack’s “theoretical rectangle”). Note especially the block of 31 tesserae in the upper left of the Right panel and the set of 9 in this block’s upper left.

concluded that the ceramic base had been broken “by a heavy blow from the rear” that dislodged some of the polygons, leaving only a single piece that overhung the plaster. It is not clear if he considers the break—and the possibly missing polygons—accidental or intentional, but the broken edge of the base appears to have been re-beveled (Marshack 1977, fig. 6). In addition, the sizes and arrangements of the polygons in the Right panel are variable. Instead of conforming to the base-4 standard units in the 8-16-32-64-128 doubling pattern evident in the Left and Central panels, the Right panel currently displays a total of 78 tesserae, some of them unusually large, in distinctive combinations within units, groups, and blocks.

For example, the upper half of the Right panel consists of two blocks: the left block has 31 polygons (including one group of 9 and another of 6), with

TABLE 11.1. Standard Arrangements of Tesserae in Left and Center Panels

Standard Unit	4 tesserae
Pair	8 tesserae
Group	16 tesserae
Block	32 tesserae
Square/Column	64 tesserae
	128 tesserae

TABLE 11.2. Counts of Tesserae in Right Panel

Units	2, 3, 4 ($n = 12$), 5 tesserae
Groups	6 ($n = 2$), 7, 8 ($n = 4$), 9 tesserae
Blocks	13, 16, 31 tesserae
Column	n/a tesserae
“Extras”	5, 6, 7 tesserae
	78 tesserae

the right block having 13 tesserae plus 7 “extra” or “residual” tesserae in a column at the extreme right (total: 51). The lower half has one block of 4 SBUs or two pairs, with a row of 6 extras below and 5 to the right (total: 27). Note that some of the sets of polygons in the Right panel reflect important numbers in Mesoamerican cosmology, including 9 and 13.

In his study of the mosaic, Marshack's (1977, 361, fig. 7) estimated a total of 384 tesserae (354+30), including the 18 missing polygons on the right edge of the Right panel, plus 30 more that were part of a “theoretical rectangle” (note that his figure 7 erroneously says 245). This rectangle would make the Right panel nearly equivalent to the 128 tesserae in each of the other two sections. He believed there had been an “intentional subtraction of 30 pieces” in this theoretical rectangle, apparently as a result of the blow to the underside of the piece (Marshack 1977, 352, 361).

CUTTING THE TESSERAE

The manufacture of this mosaic was complex, the pyrite tesserae having been cut to fit so precisely that there was not enough space between the pieces to fit a razor's edge (Marshack 1977, 356). Marshack's study concludes that each of the polygons was cut, shaped, and inlaid separately, and, given pyrite's (FeS_2) common occurrence in relatively small nodules, this seems to be a reasonable conclusion (Marshack 1977, 356, 361–63). Nonetheless, the mineral's hardness (6–6.5) and lack of natural cleavage planes would have made the creation of this mosaic—cutting and grinding of the minute pieces—an extremely arduous project (Marshack 1977, 341).

The overall layout and precise fit of the polygons suggests that an alternative explanation for the creation of the mosaic might be sought. Large pyrite

crystals measuring up to 25 cm may occasionally occur, particularly in hydrothermal veins (Anthony et al. 2001–2005). Perhaps for this artifact one rare, unusually large nodule of pyrite was shaped to a sheet- or plate-like piece having the dimensions of the ceramic plaque (ca. 14 × 8 cm) and then polished to create a flat, shiny surface. This sheet was then reduced to smaller and smaller pieces by a series of alternating vertical and horizontal cuts. The first cut would have divided a single large piece into approximately equal thirds, creating the Left, Center, and Right panels. Alternatively, perhaps three smaller (ca. 8 × 5 cm) pieces of pyrite were shaped to form the panels.

Each panel was then halved horizontally, resulting in six roughly square pieces (what I call squares here). In the Left and Center panels, each square was cut vertically to create four rectangles or blocks. Each block was halved horizontally, creating two groups in each, and then each group was halved vertically into pairs. Finally, the pairs were reduced to SBUs composed of four usually quadrilateral polygons. Note that in the discussion below I do not count the 18 tesserae on the far right of the Right panel (dotted lines), because these are based on Marshack's reconstruction and there is no direct evidence that they were there after the piece was altered.

The cutting procedure for the Right panel was obviously not intended to repeat the relatively uniform SBUs of the Left and Center, although despite the removal of pieces from the right edge, the panel retains suggestions of a block-level layout. The upper half was cut into two blocks: the left one was divided into pairs or “quasi-pairs” of 9, 6, 8, and 8 tesserae, while the abbreviated right block retains 13 tesserae, plus a column of 7 extras on the broken right edge. The lower half was cut into a large block of unusually large SBUs and groups (16 total tesserae), with ungrouped extras/residuals of 6 below and 5 to the right (total: 27).

In this reduction model of cutting, the tesserae could easily be cemented back together in their original positions with perfect fit because they were created by successively subdividing a single plate(s) of mineral.

Marshack (1977, 363–68) identified several “anomalies” in the mosaic’s pattern. One polygon at the center-right edge of the Left panel included a “cystal,” from which a line was drawn to the edge, which he called a “late addition.” Seven tesserae are triangles, instead of the more common quadrilateral polygons. Two triangles lie in the Left panel near the bottom of each column; five triangles were set into the Right panel. These might have functioned as cues to the user of the device to perform a specific action (Marshack 1977, 363–65). Similarly, the different angles of cutting and shaping units or pairs within groups also might have had some functional meanings.

POSSIBLE FUNCTIONS OF THE LAS BOCAS MOSAIC PLAQUE

Marshack's "cognitive analysis" of the mosaic led him to conclude that the individual polygons or tesserae represented days and that the object was used in maintaining records of time, specifically lunar time. Marshack (1977, 370, citing Michael Coe, apparently personal communication) also noted that the pattern of compiling the units of the mosaic in successively larger squares of four—which I consider to be a process of successively reducing larger sets down to smaller squares—could be seen as an early template for the sequence of writing and reading glyphs. He considered that the blocks and columns were "read" or counted in a "boustrophedon" pattern, that is, in alternating left-to-right and right-to-left sequence from top to bottom.³

I do not disagree with the usages suggested by Marshack, particularly the idea that the individual polygons represented days and the object itself facilitated counting and notation of time's passage in the early development of formal calendars. But Marshack's lunar-based conclusion can be greatly expanded, particularly if we consider the sets of polygons in the Right panel as meaningful variations rather than "aberrant" indications of a "breakdown" in the artisan's "control" of manufacture (Marshack 1977, 361). The mosaic would have been an effective device for facilitating calculations of various units of time (days, years, or other intervals) relating to multiple celestial phenomena and calendars recognized in ancient Mesoamerica, not just lunar time.

That is, given the Mesoamerican emphasis on quadripartition, the standard base-4 schema of the Left and Center panels enables many fundamental and repetitive counting and multiplication operations. The variable sets of non-base-4 tesserae in the Right panel—countable as 3, 5, 6, 7, 9, 13 (and also 14, 15, and 17, by combining units in the upper left block)—give the mosaic considerable arithmetic flexibility. They permit counts or multiplications that are not accommodated in the standard arrangements of the other two panels. Alternatively, if the mosaic were used abacus-fashion, counts in the Left and Center panels could be registered as collective tallies in the Right. Finally, the triangles positioned among the polygons might have triggered some special arithmetic function, such as addition, subtraction, or multiplication/doubling. All in all, this plaque could have been a broadly useful device for "skywatchers" (Aveni 2001), "daykeepers" (B. Tedlock 1992), calendar priests, or shamans to calculate and track time's passage in the past, present, and future.

THE 260-DAY CALENDAR

The Left and Center panels of the Las Bocas mosaic each consist of two columns of 64 polygons, for a total of 128 tesserae/days per panel, and a combined 256 for the two panels. This is four days short of the widely shared and very early Mesoamerican 260-day calendar, often called the “agrarian year” because of the maize-growing cycle of approximately 260 days (see Rice 2007, 35–36).⁴ As Marshack noted, the bottom left unit of each column in the Left panel contains a triangle, which, in counting 260 days, may be a cue to count that particular piece twice. This would give a count of 64 plus 1, or 65, and 65 in each column, for a total of 130 tesserae/days (hereafter t/d). Repeating this for the Left panel alone—or using the cues in the Left panel to remind the user to also add two more to the Center panel count—gives a total of 260 t/d.

THE 365-DAY CALENDAR AND RELATED SOLAR PHENOMENA

Mesoamerican 365-day calendars consist of eighteen “months” of 20 days each, for 360 days, plus 5 additional days, typically viewed as unlucky or dangerous, to approximate the solar year. The days of the 365-day year can be counted using the 128 t/d in the Left and Center panels plus the 78 polygons in the Right panel, for a total of 334 t/d. This is 31 days short of 365, but the 31 tesserae in the Right panel’s upper left square can be added again (note triangles). Thus: $128 + 128 + 78 + 31 = 365$.

The 365-day year also can be considered as 260 days plus 105. Counting 260 t/d is easy (4×65 , as shown above), so the issue becomes one of counting 105 days. This number can be reached as 78 (the number of polygons in the Right panel) plus 27, the total number of tesserae in its lower half (counting this half twice might be indicated by the triangle) at the bottom. Thus: $260 + 78 + 27 = 365$.

In addition, the plaque can be used with reference to the solar calendar to estimate leap years, register yearbearers, and estimate equinoxes. For example, the 365-day calendars are not precise for estimating the true solar year,⁵ which astronomers now measure at 365.2422 days, a fraction accommodated every four years in the modern Gregorian calendar by “leap” years. In the Mesoamerican calendars, this imprecision led to the loss of one full day every 1,508 days, or 31 days every 128 years. Here again the mosaic plaque provides a convenient way of tallying this with its count of 128 tesserae (years rather than days, in this case) in the Left and Center panels. The loss of 31 days per 128 years is registered by the 31 tesserae in the upper-left block of the Right panel and was accommodated by the addition of five days (note 5 extra

tesserae along the right edge) in Mesoamerican calendars: Maya Wayeb' days and Nahua Nemontemi.

An important component of the 365-day calendar involves yearbearers. The Mesoamerican yearbearer cycle is completed after four years of 365 days. Counts of four years are easily made by using individual tesserae (four per SBU) or groups (four per square), because of the base-4 concept of the mosaic arrangement. Four years totals a count of 1,460 days, which can be divided by 20 to equal the number of "months" in the cycle, that is, 73. If we take the 78 tesserae in the Right panel and subtract the 5 extras on the right edge, we have 73.

It has been proposed (Edmonson 1988, 111) that there might have been a 364-day calendar very early in the development of Mesoamerican calendars. This could be accommodated by the mosaic pieces if one considers 364 as the sum of all tesserae in the three panels ($128 + 128 + 78$) plus another 30; 30 can be reached as the 31 of the upper-left square in the Right panel, minus 1 (prompted by one of the triangles). Alternatively, $364 = 4 \times 91$ or, computed differently, $364 = 4 \times (7 \times 13)$. A block of 13 polygons, with 7 adjacent extras or residuals, can be found in the upper right of the Right panel.

It is also possible to tally the 186 days between equinoxes. This is not conveniently accomplished using the 64- or 128-count columns in the Left and Center panels. Instead, it seems to be best accommodated in the Right panel, because 186 can be counted as 2×93 , 3×62 , or 6×31 . We have already seen that the upper-left block in the Right panel consists of 31 tesserae, and 6 polygons exist in the upper right as well as in the lowest row in the panel. One of these latter 6 is a pendant triangle, perhaps indicating a multiplier.

LUNAR CYCLES AND THE SUPPLEMENTARY SERIES

Marshack's (1977) original analysis of the mosaic led him to conclude that it could be used to count days in a lunar year, but this conclusion is based on his "theoretical rectangle." His projected total of 384 tesserae (rather than 334 existent polygons) tallies "the number of days in an observational 13-month 'long' lunar year ($13 \times 29.5 = 383.5$). Such a long year of 13 moons encompasses either two solstitial or two equinoctial solar observations at an interval of 365 days. It could also represent the intercalary year needed to bring solar and lunar years into phase" after advancing unequally for a period of time (Marshack 1977, 361).

A lunar "semester" of 177 or 178 days can be tallied on the mosaic. Adding the 128 polygons of the Left or Center panels to the 31 tesserae in the upper-left block in the Right panel gives a total of 159. The remaining 18 (to total 177)

come from doubling the 9 in the upper-left corner; such doubling might be cued by its two triangles. Thus: $128 + 31 + 9 + 9 = 177$.

Certain components of the Right panel include numbers that are significant in Mesoamerican timekeeping and ritual, such as 9, 13, and 7 (the latter two totaling 20), all of which are elements of lunar cycling (Macri 2005). Records of lunar phenomena considerably antedate the development of Mesoamerican calendars and have been noted on objects in Paleolithic Europe (Marshack 1972). These have not been identified with comparable antiquity in Mesoamerica, although a possible lunar tally, a petroglyph at Presa de Mula in northern Mexico, may date to ca. 3000–2000 B.C. (Aveni 2002, 62–63). Lunar timekeeping is important in relation to agricultural cycles in some areas of Mesoamerica (Milbrath 1999, 27–31) as well as human gestation (e.g., Earle and Snow 1985; Neuenschwander 1981).

Lunar record keeping seems to have been elaborated, if not perfected, by the Late Classic Maya. Maya long count dates often include the Supplementary Series, which consists of up to 10 glyphs (evoking a link with the two sets of 5 extras on the mosaic's right edge) that archaeologists designate by letters. These provide information about the moon on the date being recorded. It is thus likely that the Classic Maya merely formalized in hieroglyphic writing the various observations of the moon's changes that had been useful in assessing time's passage for millennia.

Two of the Maya Supplementary Series glyphs, Glyphs G and F, refer to the Nine Lords of the Night, and Glyphs Z and Y seem to designate an incompletely understood lunar cycle of 7 (Harris and Stearns 1997, 16). Glyph C was used to identify the current “lunation,” one of a series of 6, and Glyph X also named the lunation: at least 13 variants of Glyph X are currently known (Harris and Stearns 1997, 17). All these numbers—9, 7, 6, and 13—are prominent among the groups and extras on the Right panel of the plaque.

VENUS CYCLES

The planet Venus, third brightest object in the sky after the sun and moon, exhibits a complex pattern of movement, appearing for a time as Morning Star, disappearing, and then reappearing as Evening Star. The planet is invisible in the intervals between Venus's major appearances.

A Venus cycle or “year” consists of 584 days, that is, it takes 584 days before Venus exactly repeats its same positions in the sky. The arrangements of tesserae on the mosaic plaque allow the total of 584 t/d to be reached in two ways, both of which make use of the Right panel. First, 584 is equal to the Left and

Center panels of 128 tesserae each, totaling 256, which when multiplied by 2 is 72 days short of 584. That missing 72 t/d can be accounted either as 8×9 or $64 + 9$ (i.e., re-counting one column of 64 plus the 9 polygons in the upper-left group of the Right panel), or as all 78 tesserae in the Right panel minus the lower 6. Second, $584 = 8 \times 73$, where 73 is, as already noted, the number of tesserae in the Right panel, minus 5 extras.

In addition, five Venus years of 584 days correspond to eight years of 365 days, or 2,920 days. That is, 2,920 days have to pass before the exact recurrent positions of Venus will appear again in the sky. The total of 2,920 days can be envisioned as two yearbearer cycles of 1,460 days (see above) or as $2 \times 73 = 146$ 20-day months. Counting of these periods could proceed as discussed above, using multiples of 8 (tesserae per pair, or 8 groups per panel).⁶

THE 819-DAY COUNT

A count of 819 days is an unusual feature of Classic Maya timekeeping, and its origin and rationale have not been well understood (Berlin and Kelley 1961). Recently, however, Gerardo Aldana (2007, 122–25) proposed that this count was invented at Palenque in the early eighth century by three nonroyal elites: *sajal Yuhk Makab'te*, *aj k'ujuun Chak Chan*, and *aj k'ujuun Mut*. This count is related to Maya God K/K'awiil, who was patron of, among other things, royal lineages in the Classic period (A.D. 200–900) (materialized as the manikin scepter) and of *k'atuns* in the Postclassic period (A.D. 900–1519), as seen in the Paris Codex (Love 1994; Milbrath 1999, 227–40; Rice 2012; Taube 1992). The 819-day count is one-fourth of a ritual circuit of 3,276 days, during which God K tours the four cosmic quarters. The total of 819 days is a multiple of $7 \times 9 \times 13$ (see the Right panel), which multiplied by 4 equals 3,276 (Aldana 2007, 110; see also Harris and Stearns 1997, 17). This count was an “elegant algorithm” that permitted tracking of the long-term movements of Jupiter, Mars, Mercury, and Saturn (Aldana 2007, 112–13; Justeson 1989, 78, 103–4). It is doubtful that such precise, composite planetary tracking was possible in Mesoamerica as early as this mosaic plaque, if it is indeed as old as suggested, although the component numbers of the count certainly were recognized.

OTHER ASTRO-CALENDRICAL POSSIBILITIES

The Postclassic Maya Dresden Codex provides a table that deals with the 780-day intervals of cycles of appearance of the planet Mars, and mentions a “78-day period that is very close to the average retrograde period (75 days)” of

Mars (Milbrath 1999, 219). As with the 819-day count, it seems rather incautious to speculate that this early plaque bears a reference to the movements of Mars, but the planet's red color might have captured the interest of early Mesoamericans, and it is otherwise problematic to explain the existence of 78 tesserae in the Right panel of the mosaic. A total of 780 days—the Right panel total times 10 (two counts of 5 extras on the right edge)—is also, of course, the sum of three 260-day calendars.

Finally, the Postclassic and probably also the Classic lowland Maya observed “Burner cycles” of four units of 65 days, divided into 20, 20, 20, and 5; the total cycle is 260 days. These segments of Postconquest or Colonial period (A.D. 1519–1697) Burner rituals (Long 1923, 174) began on four specific named and numbered days in the 260-day calendar and were associated with ritual fires and also ceremonies involving deer in the dry season (see Rice 2004, 245–48). The four days implicated in these rituals represent a type of yearbearer that may have been recognized only by the Olmec (Edmonson 1988, 21, 231). The 65 days of the Burner cycle, like those of the overall 260-day calendar, would have been easily accommodated by the same procedure discussed above: counting the 64 t/d in the columns of the Left panel, with each triangular piece counted twice to reach 65.

DIVINATION

Pyrite mirrors in Mesoamerica are traditionally considered ritual objects for divinatory conjuring or scrying, peering into the Otherworld for various sorts of occult, oracular communications (Healy and Blainey 2011), and this is certainly one possible function of the Las Bocas artifact. A different kind of usage in divination is suggested by analogy with Dennis Tedlock’s description of a contemporary K’iche’ Maya (highland Guatemalan) daykeeper’s procedure. D. Tedlock (1996, 340) notes that these daykeepers work with the hard, red, bean-like seeds of the coral tree (*Erythrina corallodendron*; Spanish *palo pito*; K’iche’ *tz’ite*). In a divination to solve a client’s particular problem, the daykeeper sits at a table and arranges handfuls of coral seeds so that they are

. . . sorted into lots of four seeds each, arranged in parallel rows so that the days can easily be counted on them, one day for each lot. When seeds are left over from the division into fours, a remainder of three seeds is made into two additional lots (with two seeds in one and one seed in the other), while a remainder of one or two seeds counts as one additional lot. Once the clusters are complete the diviner begins counting the days of the 260-day cycle, starting

in the present (the day of the divination itself), the past (the day the client's problem began), or the future (the day of an action contemplated by the client). The augury is reckoned from the portent of the day that is reached by counting through to the final lot of seeds. (D. Tedlock 1996, 232n70)

In other words, modern Maya daykeepers perform their divinations by counting lines of seeds arranged in "lots" of four (analogous to the columns in the Left and Center panels of the mosaic), with the "leftovers" creating additional lots (the Right panel). The antiquity of this practice and the degree to which it might be shared more widely in ancient Mesoamerica are unknown.

CONCLUDING THOUGHTS

Specialized devices related to observational astronomy and time reckoning were "power objects" in the context of evolving early leadership positions in Mesoamerica (Rice 2007; 2008, 281). Such objects were frequently created using exotic materials and/or exhibit extraordinary labor investment. In the Isthmian region, mirrors were among these important early symbols and ornaments of chiefly power, prominently displayed in headdresses or as pendants, and dating as far back as the Early Formative period (1500–1000 B.C.) (Carlson 1981; Clark 1991; Heizer and Gullberg 1981; Rice 2007, 29). These early mirrors are typically round and concave, carefully ground out of a single block of highly polished iron ore, rather than flat mosaics.

The Las Bocas mosaic "mirror," although of atypical composition and form, falls into the category of early power objects. The holes drilled into the back and beveled long edge of the ceramic indicate that it would have been worn suspended as a pectoral (figure 11.3). Marshack's (1977, 367) interpretation of the direction of inlay of the tesserae suggested that the wearer lifted the plaque for examination from left to right, whereas when viewed by observers it would have been backward and upside-down. (In addition, the use-wear on the edges of the base suggests that the piece might have been stored and manipulated while resting on a flat surface.)

I assume the Las Bocas mosaic was the possession of an ancient Mesoamerican magico-religious practitioner of some sort (shaman, skywatcher, daykeeper, calendar priest, etc.), who was likely an elite and also a sociopolitical leader (for the later Classic Maya, see Healy and Blainey 2011). For a person with such duties and skills, an object like this plaque would have been a useful and powerful device for both tracking and predicting multiple celestial and calendrical phenomena. It linked the present to the past and the time of the ancestors, and also to the future, through multiple coordinates in the

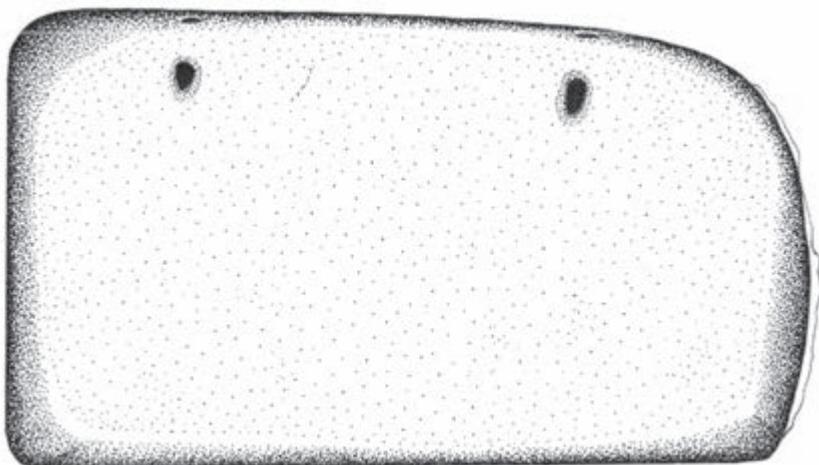


FIGURE II.3. Perforations on the underside of the mosaic plaque, indicating that it was suspended and probably worn as a pectoral (redrawn from Marshack 1977, fig. 3). Note the beveled edges and the slight overhang of “plaster” on the right edge.

region's various calendars. It permitted communication with the supernaturals overseeing the cosmos. The Las Bocas mosaic, and other mirrors as well, are thus not merely early symbolic representations of politico-ritual power and wealth, but instead may be considered “actual encapsulations or embodiments of cosmological power” (Helms 1993, 215). The esoteric knowledge of how to manipulate these instruments allowed the wearers/users to appear to “control” time and the movements of celestial bodies, and so impose their ideas of social and cosmic order as apparent supernatural directives.

My exploration of possible arithmetic operations that could have been performed through counts of polygons on the Las Bocas mosaic plaque suggests a wide range of possible astro-calendrical uses beyond divination (table II.3), but of course there is no proof that the object was actually so used. The standard base-4 units of the layout are founded on a key number in Mesoamerican thought, enduring for millennia in the concept of quadripartition in cosmology and world view. If the above reconstructions are valid, the three panels seem to have served distinctly different arithmetic purposes. The Left panel seems to have been the primary means for tallying counts of 64 and 65, particularly in the 260-day calendar and other similar units, such as the Burner cycle. This panel is distinguished from the Center one, both of which exhibit regular, base-4

TABLE 11.3. Possible Astro-Calendrical Tracking and Predicting Functions of the Las Bocas Mosaic Plaque

<i>Calendar or Cycle</i>	<i>Panel</i>	<i>Comment</i>
260-day	Left (and Center?)	
365-day	Left (and Center?) and Right	Also: tracking the yearbearer cycle; tracking a possible 364-day calendar; counting days between equinoxes; tracking the loss of 31 days every 128 years, hence the need for the 5 extra (Wayeb') days
Lunar	Right	
Venus year	Left, Center, Right	Excluding correlations with 8 solar years
819-day	Right	
Mars	Right	
Burner	Left	

multiples or SBUs of polygons, by the presence of a triangle in each column. The Center panel seems to be largely a way of doubling or multiplying counts of 128, but it might have had some other use not discovered in the present analysis.

The Right panel differs notably in shape and in groupings and totals of tesserae. Unlike the regular arrangements of the Left and Center panels, the Right panel has unusual counts of polygons in “quasi-pairs,” plus five triangles and extra or residual tesserae in combinations of 5, 6, and 7. The polygons in this panel seem to have been combined for the purpose of tallying irregular counts that could not be assimilated by the standardized arrangements of base-4 units in the other two panels. It is not unlikely that other counts, such as subdivisions of astral or other calendrical cycles, also could have been accommodated by the groupings of tesserae in this panel. Thus, rather than being an aberration evidencing the maker’s lack of skill in shaping the polygons (Marshack 1977, 361), the unusual sizes and numbers of polygons in the Right panel appear to constitute a strategic and mathematically sophisticated functional adaptation to the complex tasks at hand.

The authenticity of this mosaic plaque—as a genuine Precolumbian artifact—may be questioned for many reasons (see note 1), including the fact that it is a one-of-a-kind item: nothing like it had been recovered before its appearance or has been since. Nonetheless, I do not find its uniqueness alone to be a satisfactory basis for dismissing the possibility that it is a genuinely old artifact. Another unique object with calendrical functions is the wooden Chamula “calendar board,” used by a Maya shaman in Chiapas until 1968 (Gossen 1974; Marshack 1977, 343–47). To the contrary, it is not inconceivable

that an extremely astute, computationally adept, and probably very powerful daykeeper/calendar priest/shaman might have had a highly skilled craftsman produce an extraordinary device such as this. The computational (and mnemonic) functions of the Las Bocas mosaic would have permitted rapid calculations of important units of time and celestial movements, and when worn and consulted, it would have profoundly communicated the leader's supernatural powers to those in his presence.

It is unfortunate that the dates of creation or formalization of various Mesoamerican calendars are not well understood (Edmonson 1988; Rice 2007), because these might shed light on the possible antiquity of the mosaic. It is generally agreed that the 260-day calendar is very old; its day names and numbers may predate the separation of major Mesoamerican languages around 4000–3000 B.C. The date of development of the 365-day solar calendar is less certain. The two calendars were integrated into the calendar round (of 52 years) by the sixth century B.C., as illustrated on two stelae at Monte Albán, in Oaxaca, which bear calendar round dates of 594 and 563 B.C. (Marcus 1992, 38–41). Thus the 365-day calendar—which consists of 360 days plus five added days to more closely approximate the true solar year—must have developed well before this, considering the difficulty of calculating the five-day adjustment.

This chapter does not support the lunar counts proposed by Marshack, and the numerical counts I include here are quite different from Marshack's, who derives some of his counts from a “theoretical rectangle” that presumes the panel was once rectangular in shape, a premise that I find unacceptable. My methods and conclusions differ markedly from Marshack's, and on the basis of the arithmetic functions described herein, I suggest that we should not summarily reject the possibility that the Las Bocas mosaic plaque is a genuinely ancient calculator-like tool used by a Mesoamerican skywatcher or shaman or record-keeper (although not necessarily an Olmec). The skill and reputation of such emerging specialists would have been considerably enhanced by an object that permitted rapid and repetitive counting of extremely large numbers, such as tallies of days or years. Over many generations, the esoteric knowledge of these or other pathways for tallying the polygons and the combinations of areas of the mosaic useful for each calculation would have been memorized, making the mosaic as easy for them to navigate as an ancient Asian abacus or the tiny, multifunctional phone/camera/computer/music players we use in the early twenty-first century. Eventually (after the development of writing and formal calendars, for example) the plaque might have become an heirloom, by then possessing a largely symbolic mnemonic role.

In sum, the Las Bocas artifact is either a remarkably sophisticated astro-calendrical calculator-like instrument, regardless of its date and provenience, or an elaborate hoax. If the latter, the mosaic was created in the first half of the twentieth century by someone with a vast and detailed understanding of Mesoamerican calendrics as well as fairly modern astronomy. Further analysis of the object itself (e.g., microscopic, mineralogical, and chemical compositional analyses of its constituents) will be required to distinguish between these alternatives.

NOTES

1. Besides questions about this mosaic plaque's provenience, it has a number of stylistic features that are unusual and add to concerns about its authenticity. These include its good condition, given that "pyrite tends to decompose rapidly in humidity" (Marshack 1977, 343; Paillés Hernández [2007] comments on heavy rains in the region and poor preservation of burials). Another is the "remarkable technological" quality of the mosaic: the tiny, close-fitting tesserae represent "roughly ten times the number of polygons normally found in an Early Classic plaque of comparable size" (Marshack 1977, 347, quoting P. Furst's unpublished 1966 thesis).

In addition, later mosaic mirrors in Mesoamerica typically have random arrangements to fill what is usually a roughly circular form; rectangular pectoral mirrors are not known in Olmec cultures (Marshack 1977, 347). Clearly the mirror should be studied as a physical object to answer questions about its manufacture. Unfortunately the present location of the Las Bocas mirror is unknown.

2. One counterargument to this hypothetical procedure concerns the often differing appearance of the surfaces of adjacent polygons, which might indicate that they came from separate nodules rather than a single sheet. Possibly this variability is a consequence of different degrees of discoloration from weathering of the surfaces of the tesserae that were cut from a single block (Marshack 1977, 343).

3. Here, I continue the top-to-bottom counting within panels, but ignore the possibility of boustrophedon movement within columns.

4. The count of 260 is also the number of *tuns* (360-day "years") in the Maya *may* cycle (approximately 256 Gregorian years). Although I have proposed that the *may* might have begun structuring geopolitical organization in the Middle Formative (Rice 2007), I hesitate to propose that this mosaic facilitated these long count-based tallies.

5. According to Munro Edmonson (1988, 117), an accurate estimate of the length of the tropical year was achieved by 433 B.C.

6. Although it is not difficult to count 365 days on the mosaic plaque, as discussed above, counting multiples of 365 t/d is quite cumbersome, and there do not

appear to be any shortcuts. That is, I have been unable thus far to identify clean multipliers of the larger panel-based totals (256, 260, 334) to result in 2,920. It is possible, then, that at the time of creation of the Las Bocas artifact Mesoamerican calendar-keepers had not yet determined how to correlate the Venus cycle with the 365-day cycle. The Maya did not formally institute an accurate Venus calendar until the tenth century A.D. (Lounsbury 1983).

Related to the eight-year Venus cycles, I wonder if this bright planet could be the basis for the otherwise perplexingly repetitive units of 8 in the mosaic. Eight is not one of Mesoamerica's most cosmologically significant numbers (other than a doubling of 4).

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*Some Alternative
Eclipse Periodicities
in Maya Codices*

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In *Skywatchers of Ancient Mexico* and *Skywatchers*, Anthony Aveni's (1980, 80; 2001, 78) classic works on New World archaeoastronomy, one finds a table listing 25 eclipse cycles, varying in length from about 3 years to 76 years. They are all integral multiples of the lunar synodic month (the period of 29.53059 days between successive new moons, for example) or integral and half-integral multiples of the draconic month (the period of 27.2122 days "between successive passages of the moon by a given *node* of its orbit" [Aveni 2001, 97]). A concern with eclipses is a feature of three of the Precolumbian Maya codices, but only one table or almanac in these ancient Maya books has a length that matches one of Aveni's listed eclipse cycles. The match occurs with the cycle of 11,959.89 days and the 11,960-day eclipse table on pages D.51 to D.58 of the Dresden Codex (SLUB 2010). A period of 11,959.89 days is 405 lunar synodic months, almost 33 years. Given the fact that solar eclipses can happen only on new moon dates (and lunar eclipses on full moon dates), it is not surprising that an eclipse table should be cast in terms of synodic months. But why, although eclipses were frequently tracked, is this the only ancient Maya astronomical record that is structured in terms of the synodic month?²¹

The answer to this question comes from a close look at the eclipse table. It has three eighth-century entry dates, not just one. These are:

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- 9.16.4.10.8 12 Lamat 1 Muan² (10 November A.D. 755 Gregorian)
 9.16.4.11.3 1 Akbal 16 Muan (25 November A.D. 755)
 9.16.4.11.18 3 Edznab 11 Pax (10 December A.D. 755)

Although a full expansion of any one of these dates through all the distance numbers in the 69 columns of the table adds up to 405 synodic months, the table does not work accurately if only one of the entry dates is used. All three considered simultaneously relate to an *eclipse season*, a period just over a month in length (node \pm 18 days; ca. 37 days), centered on a day of lunar nodal passage, during which at least one solar eclipse and at least one lunar eclipse will occur somewhere in the world (figure 12.1). (This we have explained in greater detail elsewhere [H. Bricker and V. Bricker 2011, 275–301].) Operationally, then, the length of the Dresden Codex eclipse table is not 405 synodic months, but rather 69 eclipse seasons. And this is the key to the Precolumbian Maya treatment of eclipses.

The fundamental work on this topic was done early in the last century by an American chemical engineer, John Edgar Teeple. He noted that the mean temporal distance between days of lunar nodal passage that are at the centers of eclipse seasons is 173.31 days, a period of time called the *eclipse half-year* (Teeple 1931, 90). This was, of course, well known to astronomers. Teeple's contribution was to point out that three eclipse half-years, 519.93 days, is almost exactly the same as twice the length of the 260-day *tzolkin* or sacred calendar of the Maya, 520 days. This related an aspect of astronomical reality to a cultural cycle of fundamental and paramount salience to ancient Maya culture. The astronomical reality that fits or commensurates so well with the *tzolkin* is not the synodic month, which commensurates very poorly with a 260-day period, but rather the eclipse half-year, three of which are almost exactly a double *tzolkin*. For use in further discussion of ancient Maya eclipse cycles, we can designate the value of a triple eclipse half-year as one Teeple Number (TpN), thereby recognizing the importance of Teeple's brilliant observation. We examine here a few of the codical almanacs and tables in which eclipses are important to see how they make use of the Teeple Number and multiples thereof.

There are two almanacs—one on pages D.38b to D.41b of the Dresden Codex (SLUB 2010) and the other on pages M.10a to M.13a of the Madrid Codex (Codex Tro-Cortesianus 1967)—that have lengths of 520 days, which is one Teeple Number. The almanac in the Dresden Codex (figure 12.2) refers to an eclipse season, represented by a pair of solar and lunar eclipse glyphs above

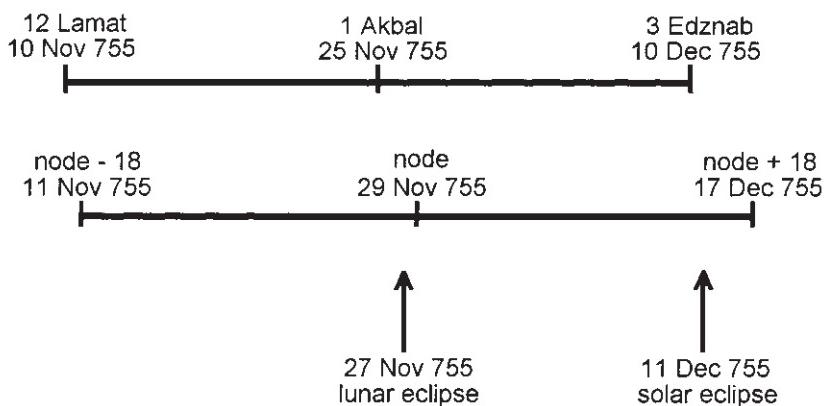


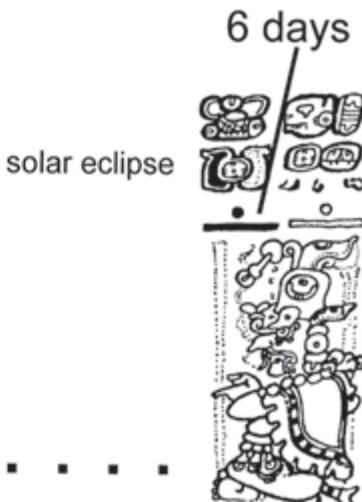
FIGURE 12.1. Relationship of the three entry dates of the Dresden Codex eclipse table to the limits of the eclipse season of November–December A.D. 755, defined as the day of lunar nodal passage ± 18 days (after H. Bricker and V. Bricker 2011, 255, fig. 9–9).

picture 1, at the beginning of the almanac, and a solitary solar eclipse glyph above the last picture, picture 11. The 520-day length of the almanac links the first and last in a series of what are in fact three eclipse seasons. The first interval in the almanac—16 days—approximates half an eclipse season—18.5 days—more closely than half a lunar synodic month—only 14.77 days—does. The last interval in the almanac, the one associated with the solitary solar eclipse glyph, is only 6 days. This structure implies that the 16-day interval that begins the almanac represents the second half of the first eclipse season, and the 6-day interval that ends it refers to the beginning of the third eclipse season. Although the almanac includes no Initial Series date in long-count format, internal evidence suggests that the eclipse seasons referred to were in the late eighth or early ninth centuries A.D. (H. Bricker and V. Bricker 2011, 342–51).

The cognate of this almanac in the Madrid Codex (figure 12.3) also begins with a 16-day interval that in this case is associated with a solitary solar eclipse glyph. The interval associated with the last picture in the almanac, here picture 10, effaced but safely restored from the general calendrical structure, is 17 days, which does an even better job of approximating half an eclipse season than half a lunar synodic month. The glyptic caption includes a single solar eclipse glyph. Elsewhere, we have shown that if the almanac is placed in historical time, the first solar eclipse would fall during the second half of the first eclipse season and the second solar eclipse during the first half of the third eclipse



picture 1



picture 11

FIGURE 12.2. *The first and last pictures and captions of the eclipse almanac on pages D.38b-D.41b of the Dresden Codex (adapted from H. Bricker and V. Bricker 2011, 345, fig. 9–50; drawings modified after Villacorta C. and Villacorta 1976, 86, 92).*

season. The temporal placement of this almanac in the eighth to the tenth century (H. Bricker and V. Bricker 2011, 350, 356, tables 9–20, 9–22), inferred again from internal evidence, is in the same general range of time as that relevant to the Dresden Codex almanac. In both almanacs the intervening pictures and captions refer to the agricultural cycle and meteorology.

The general point to be made here is that these almanacs, like almost all others in the Maya codices, are structured around the 260-day *tzolkin*. In order to relate eclipses to the other phenomena of interest (agriculture, weather patterns) within that structure, the properties of the Teeple Number were employed. The flexibility obtained by dealing with eclipse seasons permitted the internal intervals in the two almanacs to differ slightly while maintaining the correct placements of the topical referents.

Another quantity—3,640 days or 7×520 (7 TpN)—commensurates the eclipse half-year and the *tzolkin* with the so-called Maya computing year of 364 days (Thompson 1941), which approximates both the 365-day *haab* and the solar year of 365.2422 days. 7 TpN appears in the preface to the upper seasonal table in the Dresden Codex as one of several multiples of that table.

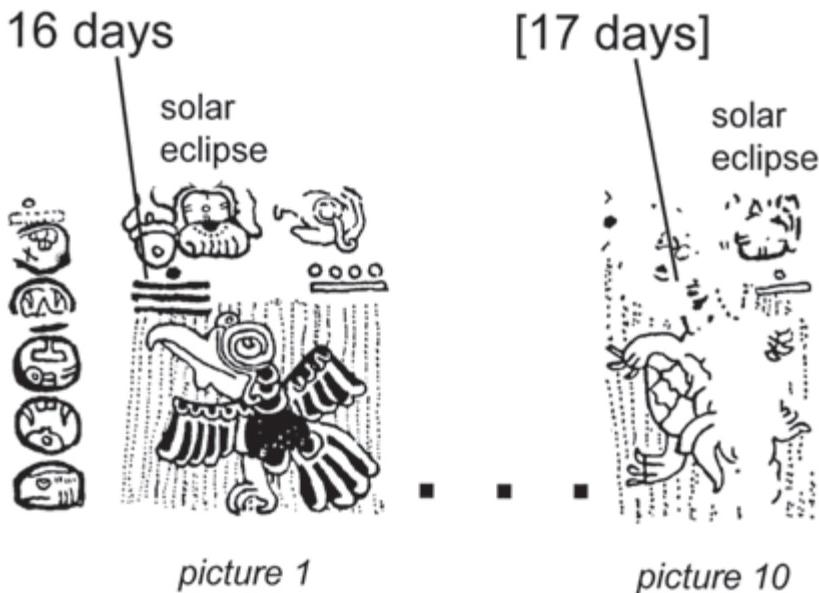


FIGURE 12.3. *The first and last pictures and captions of the eclipse almanac on pages M.10a–M.13a of the Madrid Codex (adapted from H. Bricker and V. Bricker 2011, 352, fig. 9–52, and 353, fig. 9–53; drawings modified after Villacorta C. and Villacorta 1976, 244, 250).*

The upper seasonal table contains two eclipse pictures, one on page D.66a and the other on page D.68a (figure 12.4). They are spaced in such a way that only one picture at a time can target an eclipse season, and between them they can target eclipse seasons indefinitely. Each picture is associated with two distance numbers (DNs) or intervals, one above the caption and the other between the caption and the picture. The eclipse picture on D.68a is relevant in the first run of the table. The starting date of this run is 11 October 949 (Gregorian), and a solar eclipse on 27 December is associated with a four-day interval (24 through 27 December) on page 68a that shows eclipse-season iconography. The gradual recession of eclipse seasons through the computing year means that over time this picture will lose its efficacy in targeting eclipse seasons in subsequent runs, and that function will then move to the eclipse picture on D.66a (figure 12.5), which becomes relevant for the first time in November A.D. 951 during the fifth run through the table. In both cases, the upper set of intervals is used for targeting eclipse seasons. Eventually, however, the eclipse picture on D.66a becomes obsolete, and the eclipse seasons return to the picture on D.68a, but

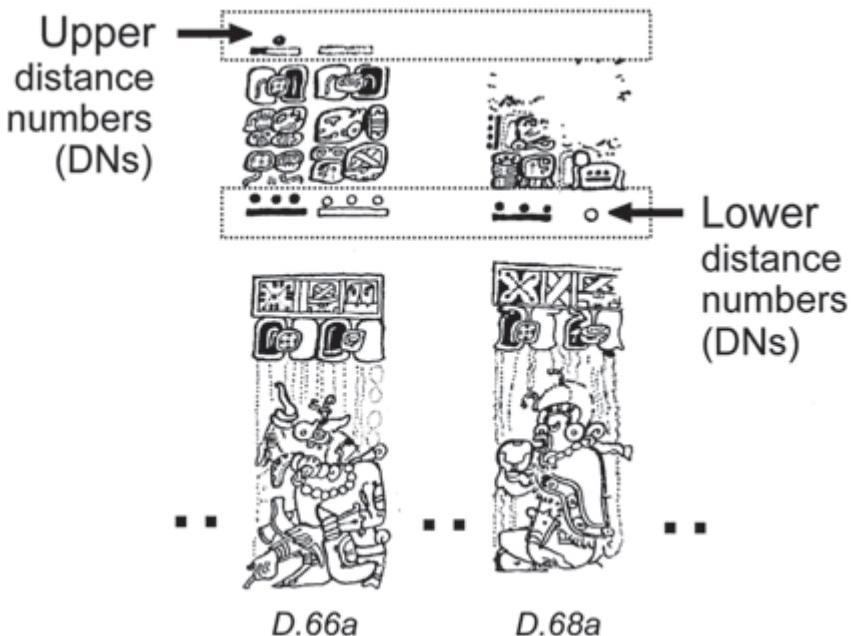


FIGURE 12.4. *The two pictures and captions of the upper seasonal table in the Dresden Codex that contain eclipse references (adapted from H. Bricker and V. Bricker 2011, 515, fig. 11–19, and 517, fig. 11–20; drawings modified after Villacorta C. and Villacorta 1976, 142, 146).*

now employing the lower of the two intervals. When that eclipse picture can no longer target eclipse seasons, they return to the eclipse picture on D.66a, continuing on with the lower set of intervals. And when the eclipse seasons move out of that eclipse picture's purview as well, they return to the upper set of intervals and the eclipse picture on D.68a, repeating the entire cycle again.

This can be seen in more detail when these changes are shown in their actual tenth-century context (figure 12.6). The eclipse picture on D.68a is represented by solid black rectangles, and the eclipse picture on D.66a by small unshaded rectangles. The large rectangles in the center of the figure represent eclipse seasons; the vertical dotted line bisecting them represents the day of lunar nodal passage, which is at the center of each season. During the first three runs through the table, the picture on D.68a is successful in targeting eclipse seasons. By the second eclipse season of A.D. 951, it has been replaced by the eclipse picture on D.66a. In the second eclipse season of A.D. 953, that task has switched to the eclipse picture on D.68a, but this time the black

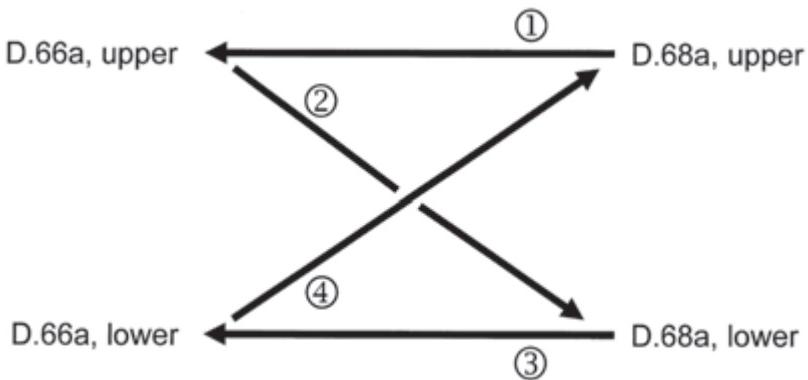


FIGURE 12.5. Sketch diagram showing how the eclipse references in the upper seasonal table in the Dresden Codex alternate between pages D.68a and D.66a and between the upper and lower distance numbers. A specific tenth-century A.D. example of such alternation is shown in figure 12.6.

rectangle is larger, in agreement with the greater length of the lower interval. In the first eclipse season of A.D. 956, the picture on D.66a regains its role in targeting eclipse seasons, with a larger unshaded rectangle showing that the lower interval is still relevant. Finally, in A.D. 958/959, the targeting function returns to the eclipse picture on D.68a and the upper interval, marked by the smaller black rectangle. Only after 3,640 days (ca. 10 years), 7×520 days, is the relationship restored between the short interval associated with one of the eclipse-season pictures (D.68a is shown here) and the node at the center of that season. This is the relationship seen in the first (A.D. 949/950) and last (A.D. 959) eclipse seasons diagrammed in figure 12.6.

The water tables, upper and lower, on pages D.69 to D.74 of the Dresden Codex, contain explicit references to two other Teeple Numbers associated with eclipse-season iconography on the final page of the tables. That page, D.74, shows a scene of a torrential downpour (not a flood), and both a solar and a lunar eclipse glyph are suspended from the skyband body of a celestial beast responsible for most of the rainfall (figure 12.7). Another component of the complex image on this page is a black god, probably God L, holding a spear and darts. The same black god, armed with spear and shield, sits above the serpent number appearing in the tables' introduction on page D.69. There are, in fact, two numbers in the serpent's coils; the black one leads to an eighth-century A.D. base date of the lower table, and the red one leads to

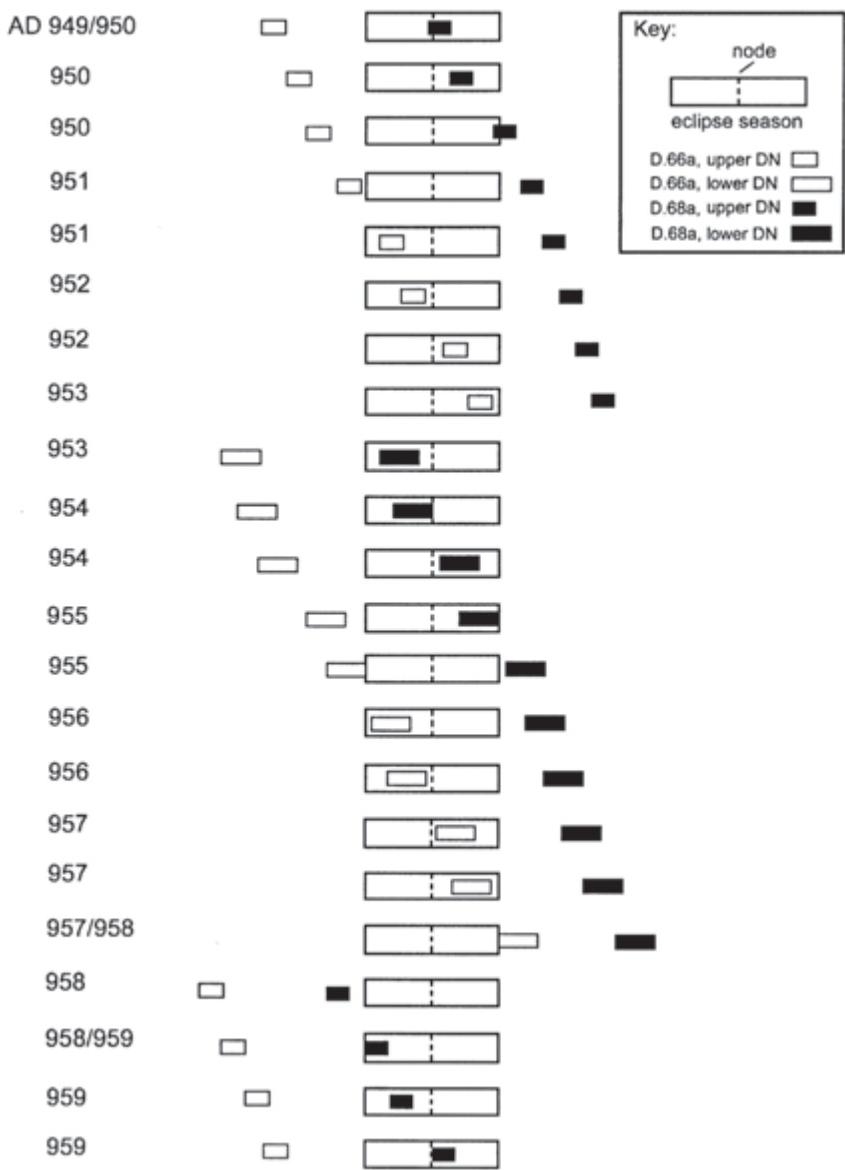


FIGURE 12.6. *Diagrammatic representation of how eclipse references in the upper seasonal table in the Dresden Codex alternate between pages D.68a and D.66a and between the upper and lower distance numbers between A.D. 949/950 and A.D. 959.*

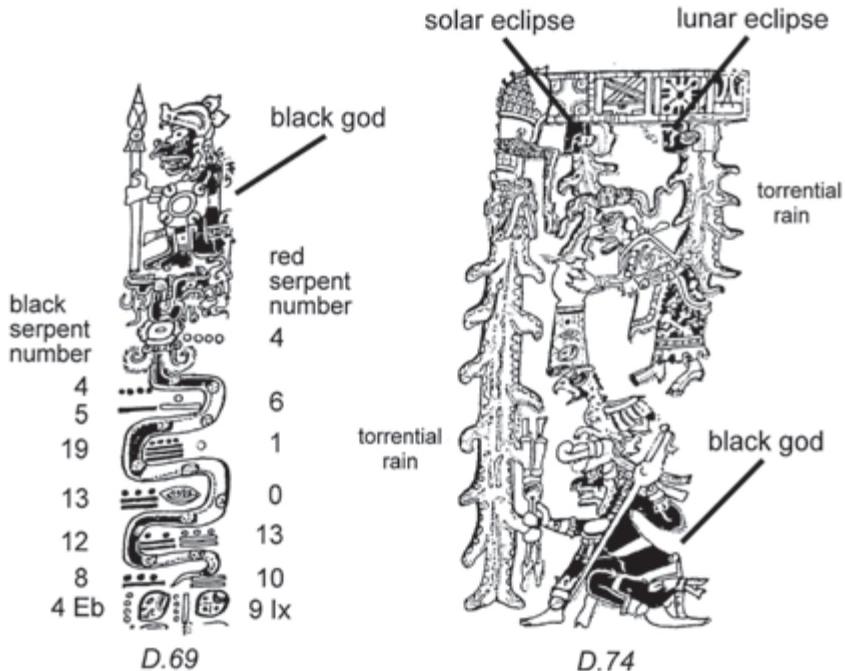


FIGURE 12.7. *Serpent numbers, eclipse imagery, and other iconographic elements in the water tables on pages D.69–D.74 of the Dresden Codex (adapted from H. Bricker and V. Bricker 2011, 400, fig. 10–19, and 401, fig. 10–21; drawings modified after Villacorta C. and Villacorta 1976, 148, 158).*

a slightly later eighth-century base date of the upper table. Both tables have multiple base dates, which range from at least the first to the twelfth centuries A.D., and it seems likely that both were revised and reconfigured more than once. Perhaps for this reason the relationship between the eclipse-season reference on page D.74 and the current-use versions of both tables is not as direct as it is in some other tables of the codex.

In the case of the lower water table, which previous scholarship (e.g., Taube 1988, 146–47) has shown to include the D.74 picture as an integral component, the base date derived from the black serpent number begins an interval that includes an eclipse season. The addition of 3,640 days (7 TpN, twice the length of the table and the lowest value given in the table of multiples in the table's preface) to that base would maintain the eclipse reference in every second run of the table (H. Bricker and V. Bricker 2011, 457–58).

What has not been recognized by previous scholarship, including our own, is that the commensurative properties of the Teeple Number relate the upper water table as well as the lower one to the eclipse iconography of page D.74. The upper water table is primarily a sidereal Mars table, concerned with the cyclic return of Mars to the same position in the sky as seen from Earth against the background of the stars. How long this takes depends on whether a given cycle does or does not include an episode of Martian retrograde motion (as explained in more detail in H. Bricker and V. Bricker 2011, 422–24). If the cycle includes retrograde, the length of the so-called long empiric sidereal interval is just over 700 days, and if not, the short empiric sidereal interval lasts just over 540 days (H. Bricker, Aveni, and V. Bricker 2001; Aveni, H. Bricker, and V. Bricker 2003). At the end of the upper water table, just before the picture containing the solar and lunar eclipse glyphs, the 20th multiple of the table's 702-day length, 14,040 days, or 1.19.0.0 in Maya notation, is prominently displayed. Its placement here rather than in the table of multiples of the preface suggests that this value, which is 27 TpN, has some special significance. Its significance for Mars comes from the fact that 14,040 commensurates both the long and short empiric sidereal intervals ($14,040 = [20 \times 702] = [26 \times 540]$), thus determining the basic numeric structure of the upper water table. But it has, as well, a significance for the eclipse cycle (figure 12.7). The base date for the upper table that is derived from the red serpent number begins a 54-day period containing part of an eclipse season, a relationship that is retained for future runs by the addition of 27 TpN to that base date. Thus, although neither water table is concerned primarily with eclipses, it was regarded as important at some point in time to relate them both to the eclipse cycle by means of the serpent number, the God L iconography, and the use of Teeple Numbers.

The preface to the Mars table on pages D.43b to D.45b of the Dresden Codex mentions still another multiple of the Teeple Number, 1,560 days (3 TpN), which commensurates 9 eclipse half-years and 6 *tzolkin* cycles with 2 synodic periods of Mars. The pair of solar and lunar eclipse glyphs in the caption over the third picture in the table (figure 12.8) refers to an eclipse season that partially overlapped a retrograde period of Mars in A.D. 818. This relationship between eclipse seasons and Martian retrograde is repeated after intervals of 1,560 days, 3 TpN, as noted previously by David Kelley (1980, S18–S19, table 5).

Finally, we consider a calendrical quantity that appears in the caption over the last picture in the eclipse table in the Dresden Codex (figure 12.9). It is a *tun* glyph with a coefficient of “13” (two bars and three dots) prefixed to it, representing 13 *tuns*, following a glyph that refers to the descent of Venus into

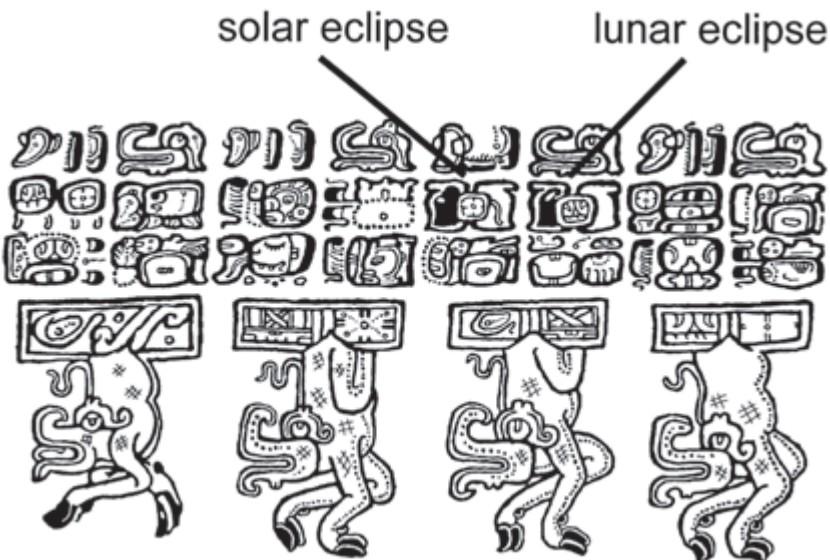


FIGURE 12.8. Pictures and captions of the synodic Mars table on pages D.43b–D.45b of the Dresden Codex (adapted from H. Bricker and V. Bricker 2011, 382, fig. 10–8; drawings modified after Villacorta C. and Villacorta 1976, 98, 100).

the underworld during its last appearance as an evening star (*elast*) before invisibility at inferior conjunction (H. Bricker and V. Bricker 2011, 318). This theme is echoed in the scene below the caption, where the Venus god is shown plunging headfirst below a pair of solar and lunar eclipse glyphs suspended from a skyband (see also Milbrath 1999, 162–63). The eclipse table's explicit intervals are multiples of the lunar synodic month—intervals of six months and five months—but 13 *tuns* is not an integral multiple of the lunar synodic month. Thirteen *tuns* contain 4,680 days (9 TpN), a quantity that commensurates 27 eclipse half-years and 18 *tzolkin* cycles with the *tun* of 360 days (instead of the 364-day computing year seen in the upper seasonal table of the Dresden Codex).³ This number has the following relationship to the Venus synodic period of 583.92 days: 8 Venus periods of 583.92 days equals 4671.36 days. Therefore, 13 *tuns* is 8.64 days longer than 8 Venus periods. This discrepancy is small enough that 13 *tuns* link the Venus *elast* mentioned in the caption over the last picture in the eclipse table with an *elast* during an eclipse season 13 *tuns* earlier and with the same pair of events 13 *tuns* later. Here, the multiple of the Teeple Number is not a multiple of the table as a whole, but rather

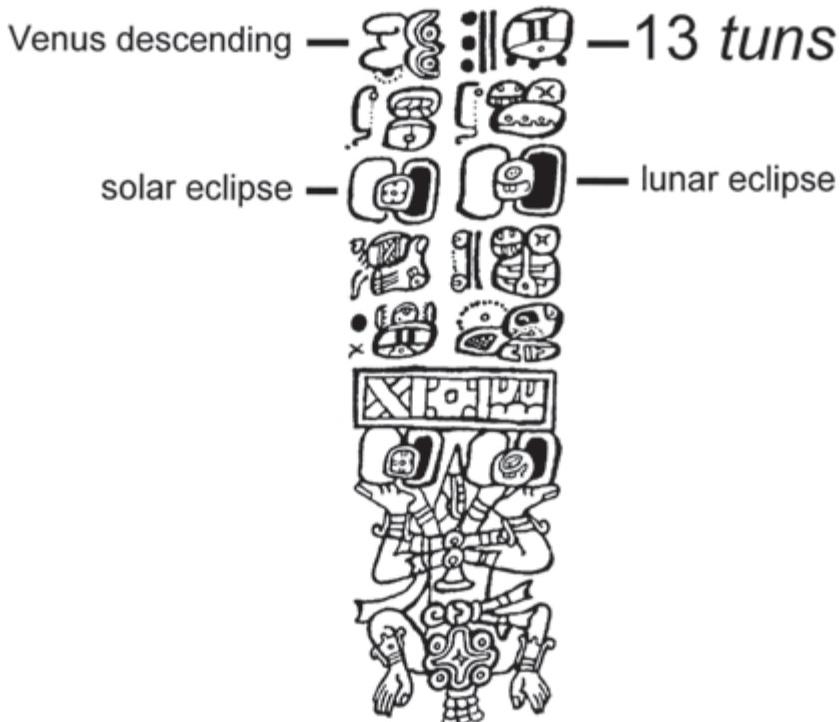


FIGURE 12.9. *The tenth picture in the Dresden Codex eclipse table and its caption, which contains a 13-tun (9 TpN) distance number (adapted from H. Bricker and V. Bricker 2011, 315, fig. 9-37; drawing modified after Villacorta C. and Villacorta 1976, 126).*

represents a distance number that links a similar chain of events within a single run of the table, as well as extending into the subsequent run of the table.

We have given here several examples from the Maya codices of how eclipse cycles are tracked and related to other phenomena using what we have called the Teeple Number, which specifies the tight commensurative relationship between the eclipse half-year and the *tzolkin*. These relationships are summarized in table 12.1. The table shows that all the astronomically related almanacs and tables discussed, whose lengths, multiples, or internal distance numbers commensurate with eclipse cycles, are odd multiples of the Teeple Number: 1, 3, 7, 9, 23, and 27 TpN. The fundamental building block of codical tables and almanacs is the 260-day *tzolkin*. Although it is most often the case that the relevant content can be expressed with a single *tzolkin*, multiples of the *tzolkin* are sometimes required.

TABLE 12.1. Teeple Numbers in the Maya Codices Discussed in the Text

<i>Eclipse Periodicity</i>		
<i>Teeple Number</i>	<i>Length in Days</i>	<i>Codical Instrument</i>
1 TpN	520	Dresden eclipse almanac (D.38b–D.41b) ^a
1 TpN	520	Madrid eclipse almanac (M.10a–M.13a) ^a
3 TpN	1,560	Synodic Mars table (D.43b–D.45b) ^b
7 TpN	3,640	Upper seasonal table (D.61–D.69) ^b
7 TpN	3,640	Lower water table (D.69–D.74) ^b
9 TpN	4,680	Eclipse table (final picture) (D.58b) ^c
23 TpN	11,960	Eclipse table (D.51–D.58) ^d
27 TpN	14,040	Upper water table (D.69–D.74) ^b

^aTotal length of almanac.

^bMultiple of the table.

^cDistance number in a caption.

^dTotal length of table.

This is particularly true when astronomical cycles are at issue. The use of the Teeple Number, a double *tzolkin*, allows the cyclicity of eclipses to be expressed in terms of the basic calendrical building block. The quantities discussed—1 TpN, 3 TpN, etc.—extend the *tzolkin*-eclipse commensuration to other astronomical cycles of interest to the Precolumbian Maya. These include:

- (a) the eclipse half-year of 173.31 days (1 TpN = 520 days ~ [3 × 173.31]);
- (b) the synodic period of Mars, ca. 780 days (3 TpN = 1,560 days = [2 × 780]);
- (c) the tropical year of 365.2422 days (7 TpN = 3,640 days ~ [10 × 365.2422]);
- (d) the *tun*, 360 days, and the synodic period of Venus, ca. 584 days (9 TpN = 4,680 days = 13 *tuns* ~ [8 × 584]);
- (e) the synodic lunar month of 29.53059 days (23 TpN = 11,960 days ~ [405 × 29.53059]); and
- (f) the long empiric sidereal interval of Mars, ca. 702 days (27 TpN = 14,040 days = [20 × 702]).

While modern astronomy texts define eclipse cycles primarily in terms of the lunar synodic month, ancient Maya astronomical specialists chose to use the eclipse season, which fits much better with their sacred calendar. Such a

choice follows a basic tenet of cultural astronomy eloquently exemplified by Anthony Aveni's (2008) recent book, *People and the Sky*: people of different cultures see the same sky, but they have different ways of looking at it.

Acknowledgments. For more than three decades we have benefited from the advice and guidance of Tony Aveni, and our lives have been enriched by our friendship with Tony and Lorraine. We were delighted to participate in the symposium in Tony's honor, and we extend our thanks to Anne Dowd and Susan Milbrath for having invited us to do so.

NOTES

1. Although the Dresden Codex eclipse table is the only one with a *total length* found on the Aveni list of eclipse cycles, one of the cumulative totals *within* the Dresden table—2,599 days in column 15, equivalent to 88 lunar synodic months—is on the list. Furthermore, 14,560 days (ca. 493 lunar synodic months), which is also on the Aveni list, is shown explicitly as the 8th multiple of the lower water table and the 160th multiple of the seasonal tables, all in the Dresden Codex (on pages D.71 and D.64, respectively), but these are not explicitly structured in terms of the synodic month.

2. Colonial Maya orthography is used throughout this chapter. See H. Bricker and V. Bricker (2011, 103) for the reasons these spellings are preferred in working with the codices.

3. The length of the Dresden Codex Venus table, which we have not discussed here because it does not contain explicit references to eclipses, is 37,960 days, equivalent to 73TpN and 104 *haabs*.

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This study develops a framework by which Precolumbian Mesoamericans, of any cultural tradition, could have successfully characterized or understood the timing of eclipses in terms of specifically Mesoamerican time-keeping constructs and practices, and thereby anticipated them. It is predicated upon the generally shared assumption that it was the *daykeepers*¹—Mesoamerican calendar specialists—who were responsible for anticipating the timing of celestial events. Daykeepers' representations of these events in surviving Precolumbian screenfolds are characteristically framed in terms of the pan-Mesoamerican divinatory (or “sacred”) calendar of 260 days.²

By exploring calendrical patterns in the timing of eclipses visible in Mesoamerica, issues are identified and a predictively adequate procedure emerges, anchored largely in cyclic rather than linear time constructs—one that would have permitted Mesoamericans to anticipate the date of every eclipse that was visible to them. Within this procedure, the divinatory calendar is indeed the most important temporal construct, but there is plausibly an important if limited role for other Mesoamerican calendrical cycles as well.

Whether Mesoamericans worked with such a model is for now purely conjectural. In particular, it is not derived empirically from current views about the main structural principles of the eclipse table of the Dresden Codex, which is our main source of direct textual evidence for Precolumbian eclipse theory. That document

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lays out a sequence of 69 successive eclipse “stations” that are generally interpreted as dates on which eclipses might be expected to occur but on which they might not be visible in Mesoamerica. These stations are now almost universally presented as consisting of nine groups of eclipse stations, each consisting of a sequence of between five and nine eclipse stations six lunations apart, followed by a final eclipse station five lunations later. Mayanists understand this pattern of eclipse stations in terms of the timing of *nodal passages*. The nodes of the eclipse cycle are the points in space where the moon in its orbit around the earth passes through the earth’s orbit around the sun; these occur at intervals of about 173.31 days. Lunar eclipses occur when a full moon is close enough to the node, within about 18 days of nodal passage, that the earth’s shadow falls on the face of the moon; solar eclipses have similar timing, except that they occur on the day of a new moon. Because 173.31 days is very close to the 177.18-day average of six lunations, eclipse-possible dates tend to occur six months apart; but because the discrepancy gradually accumulates, eventually a station is expected only five months after the previous station. If about 86.9 percent of eclipse stations occur six months after the previous station and 13.1 percent occur five months afterward, the eclipse stations occur on average about 173.31 days apart—the internodal interval.

Nonetheless, these five- and six-month intervals play no role at all in the model developed here—nor in fact does any consistently sequential representation. Comparable sequences necessarily emerge, but simply as linear sequential side effects of projections from a cyclic calendrical model. Here, instead, I explore projected dates of total and partial lunar eclipses visible in Mesoamerica from 100 B.C. to A.D. 900 to uncover temporal patterns of eclipse recurrence in the 260-day calendar; to define a Mesoamerican analogue of the nodal construct in restricted zones of recurrence in the divinatory calendar; to model a gradual drift of the eclipse zones to earlier dates in the divinatory calendar; and to devise a calendrical procedure by which calendar specialists could have anticipated the date in sacred time of every eclipse, lunar or solar, that was visible in Mesoamerica.

Empirically, this investigation is anchored in an exploration of the NASA lunar eclipse database (Espenak and Meeus 2006), the standard of the field for back-projected eclipses. Because penumbral lunar eclipses are basically not visible (Meeus 1991, 353), attention is restricted to total and partial eclipses. Among these, I examined Espenak and Meeus’s eclipse maps for lunar eclipses that were visible in all or some part of southern Mesoamerica (Zapotec country and eastward) between 100 B.C. and A.D. 900; 225 total and 534 partial eclipses were identified.³ The patterns in the data are based entirely

on the Espenak-Meeus eclipse dates: they are independent of any correlation between Mesoamerican and European chronologies, because all that is at issue is the number of days separating a pair of eclipses in the divinatory calendar—not what specific days in the calendar they are assigned to.⁴ In this essay, where specific day positions are reported, they are based on the original Thompson correlation constant (584,284).

There is one systematic source of error in my use of this data, in my determination of the relative placements of eclipses in the divinatory calendar. Different Mesoamerican groups differ on the time of day when the date in the divinatory calendar changed; nonetheless, an analytical decision on this point must be made in order to investigate the calendrical timing of eclipses in the Espenak-Meeus canon. When the time of day selected for the analysis differs from that used by a Mesoamerican daykeeper, the calendrical placement of some eclipses can differ by one day from that of the exploratory model.

To handle this issue, I treat the change of date as happening sometime during the hours that lunar eclipses are not visible; this is implemented by adding 0.4 day to the correlation constant 584,284. Under this model, each day in the divinatory calendar consists of a continuous zone during which eclipses can take place, preceded and followed by “dead” zones of daytime hours in which no eclipse can be seen. This division corresponds closely to Mathews’s ([1977] 2001, 404–6) model for a Classic lowland Mayan change around sunset and is consistent with the colonial Zapotec shift in the divinatory calendar date at noon. Note that a lunar eclipse visible late in the afternoon or early after dawn is assigned the same date as if it had occurred during the nearest evening.

This solution avoids the inherent arbitrariness of a decision about what part of the night falls in the earlier and what part in the later of two dates, and it makes it impossible for any eclipse to occur on both sides of the transition from one day to the next. In addition, under this model, any error in Espenak and Meeus’s calculated eclipse times—which is unlikely to be more than minutes—cannot affect the projected divinatory calendar date of any eclipse.

The effect of any particular decision on this point is that the patterns of eclipse recurrence in the divinatory calendar for particular eras and places in Mesoamerican history will almost surely differ in points of detail from those calculated here.⁵ Nonetheless, for the eclipse-prediction model that emerges from these results, no such differences can be consequential.

Using these assumptions and methods, I have explored the Espenak-Meeus data in an effort to learn something about the calendrical models that daykeepers might plausibly have used in Precolumbian times to determine the dates on which eclipses might take place. This means investigating (1) what

regularities or patterns in the timing of eclipse occurrence they might readily have discovered when tracking eclipses using the calendrical periods in which these occurrences were embedded; and (2) what kinds of tools the calendars, together with relatively near-term observations, would have made available to daykeepers for the purpose. Most specifically, this study investigates the kinds of framework for the recurrence of eclipses at the same dates in the divinatory calendar that could have been applied in modeling the timing of eclipses generally; ultimately, this leads to a straightforward calendrical procedure for predicting the timing of lunar eclipses.

This study presents a general framework that should have been relatively obvious, from very early times, to daykeepers who focused on the problem of eclipse prediction. Its essential components are as follows:

1. There is an almost precise ratio of two divinatory calendar cycles to three nodal passages (Teeple 1931, 90; see “Background” section below). As a result, for several years the nodes fall on the same three subsets of dates in this calendar.
2. Colonial Zapotec records suggest that daykeepers paid special attention to the recurrence of eclipses at or near the same date in the divinatory calendar, at least in the near term (about seven years).
3. Lunar eclipses occur when the date of full moon falls near the nodes. Given the near constancy of the placement of nodes in the divinatory calendar, the problem of eclipse prediction over a period of about 20 years is equivalent to the commensuration of this calendar and the lunation. Commensuration being a lynchpin of Mayan calendrical astronomy, this is an approach that daykeepers would be very likely to apply.
4. The lunation and the internodal cycles commensurate to within a day—in fact, to within less than three hours—after 11,960 days. This emerges as a key interval for characterizing eclipse occurrence in terms of the divinatory calendar (see “Eclipse Recurrence in Precolumbian Mesoamerica” below):
 - a. It is by far the most common interval separating eclipses that occur on the same day in sacred time.
 - b. At any point in history, there are always at least two such cycles operating, and on average six or seven concurrent cycles—offset from one another by an interval that is *not* a multiple of 11,960 days.
 - c. Lunar eclipses recur on the same day for up to fourteen multiples of this cycle, spanning more than 23 katuns.
 - d. Three less persistent, shorter cycles occur with fair frequency within the 11,960-day span. Correlating their recurrences with those of

ii,960-day cycles may contribute to a more elaborate theory; for now, however (see point 6), a simpler model provides a basis for reliable eclipse prediction.

5. In any era, there are three periods within the divinatory calendar, each spanning up to 26 days, in which lunar eclipses can occur. Over time, these periods gradually shift earlier within the divinatory calendar. At least three viable Mesoamerican calendrical frameworks could have been used to characterize, model, and estimate the rate at which this recession takes place; see “Defining a Mesoamerican Nodal Construct” below.
6. From an analysis of occurrences of eclipses at *or near* the same date in these eclipse-possible intervals within the divinatory calendar, a straightforward procedure emerges by which daykeepers could have anticipated every lunar eclipse visible in Mesoamerica; see “Synthesis, Conclusions, and Further Directions” below. The ii,960-day interval is a key subsidiary element to the implementation of this procedure, and to its conceptualization, separating whole sequences of eclipses whose occurrences are anticipated calendrically.

Results comparable to these apply to the occurrence of solar eclipses.

BACKGROUND

I began the work reported here to address an issue raised by Anthony Aveni on my presentation at a Society for American Archaeology symposium at which he was the discussant. That paper (Justeson 2007; also Justeson and Kaufman 1992, 1994) established the existence of an epi-Olmec astronomical cycle through an investigation of the epi-Olmec texts bearing long count dates. (In this study I use Julian [O.S.] dates throughout, the standard practice for historical work dating before the sixteenth century.)

The first passage on the stela from La Mojarra (figure 13.1)—“On [2 May A.D. 143], a sun-eating moon took place”—is the explicit statement of the occurrence of a solar eclipse that was visible at the site on the morning of the specified long count date (8.5.3.3.5: epi-Olmec correlation constant 584,265). The next passage reads, “As a piercer, earlier, Venus had shone; it was late in the day.” Venus was indeed easily visible the previous afternoon, when it was near its maximum angular distance from the sun (maximum elongation). But what is of particular interest here is that the phrasing makes this second passage a kind of background comment that would have been interpreted as providing a context for the previously mentioned event.

An explanation quickly emerged for how these two events were considered to be related (Justeson and Kaufman [1992] 1996; 2008, 164; Justeson 2007). It

T	ma-STAR-tza7	SHINE-wu		T	tukxpa	SUN-EAT	MOON
R	matza7	0-kij-wu		R	0-tuk-pa	suw-ku7s.u7	poy7a
MG	star	3A-shine-iCMP		MG	3A-happen	sun=eat.AN	moon
LT	star	it (had) shone		LT	it happens	(a) sun-eating	moon
FT	as a piercer, earlier, the bludgeon star [Venus] had shone			FT	a sun-eating moon was happening		
T	tza7-ji	wu		T	PIERCE	ma	pak-ku
R	0-tza7yji	+wu7		R	wu7tz-u7	ma	pak.kuy7
MG	3A-late_daytime	+REL		MG	pierce.AN	earlier	beat.NSTR +REL
LT	it was a late-daytime one			LT	pierc.ing	earlier	beat.er -type
FT	which was late in the day						

FIGURE 13.1. Eclipse statement on La Mojarra Stela 1, contextualized in terms of the visibility of Venus as evening star; the text is read from right to left. T = sign transliteration; R = reading, including grammatical analysis; MG = morpheme-by-morpheme gloss; LT = literal translation; FT = free translation; 3A = 3rd person absolutive (here, intransitive subject) marker; AN = active nominalization; NSTR = instrumental derivational suffix; REL = relativizer.

turns out that the opening long count date of the La Mojarra text was one of four (out of eight surviving) epi-Olmec long count dates that fall within a few days of a fixed date, both in the eclipse cycle and in the Venus cycle. In other words, the events that epi-Olmecs chose to depict on their monuments were those that took place on dates commensurating these two cycles. In the eclipse cycle, they cluster around the dates of its nodes and fall on dates in the divinatory calendar on which eclipses occur in the era of the monument. In the Venus cycle, they cluster around the date of the maximum elongation (angular distance) of the Evening Star from the sun. Kaufman and I therefore refer to it as a *circumnodal Venus cycle* (CNVC).

These convergences occur fifteen times per century, according to a recurring cycle. They divide a period of about 37,955 days into subsequences, each lasting 3, 5, or 8 Venus cycles and 10, 17, or 27 eclipse cycles, respectively. The chance that as many as three of the other epi-Olmec long count dates would have matched that on the La Mojarra record by chance, within the attested range of variation in both cycles, is less than a hundredth of 1 percent.

Two other long count dates, that of Cerro de las Mesas Stela 6 and the second one on the La Mojarra stela, also fall at the same points in both cycles, shortly after the base date. So it appears to be another station anchored in the same cycle: five of the six epi-Olmec monuments bearing texts record events that are timed in terms of this cycle.

In an added confirmation, this cycle provides a chronological framework for understanding the structural features of what Kaufman and I analyze as three short parallel segments in the epi-Olmec text on the back of a Teotihuacán-style mask, with three sacrificial events whose date is given in the divinatory calendar only (Justeson and Kaufman 2004, 2012; Justeson 2007). The dates in the three sequential text segments turn out to correspond to three successive stations in the CNVC for three successive Venus cycles (each 584 days), the first of which began at a CNVC base on 11 Storm (Yucatec *kawak*, Nahua *kiyawi-tl*).

Although Aveni agreed that the evidence for the existence and the prominence of this practice is definitive, I had expressed these results in terms the number of days by which each epi-Olmec date departs from a node, and he did not find it plausible, and did not believe, that a “node” was a Mesoamerican concept (see Aveni 2006). My view, however, was not that daykeepers worked with a concept anything like our node—a point where the moon crosses the plane of the earth’s orbit around the sun; the CNVC results were framed in terms of distances from nodes for analytical purposes, to show that the CNVC dates were associated with appearances of eclipses.

Still, this raises a substantive issue: whether there was in Mesoamerican chronology a conceptual analogue to the node. In the CNVC application, this is a chronological issue; and, chronologically, nodes can be seen as dates in the vicinity of which lunar eclipses may occur on the nearest full moon, and solar eclipses on the nearest new moon. There is indeed an obvious Mesoamerican analogue: Mesoamerican calendar specialists must have recognized that there were three separate sequences of days within the divinatory calendar during which eclipses could occur when a full or new moon fell in those spans and that they could not occur at any other times.

Some questions of interest are how these spans were recognized, defined, and talked about. There is a limited amount of suggestive data that allows us to touch on these issues. Before addressing them, however, it is helpful to review some well-trod territory, understood since Teeple’s 1930 study: the fact that eclipses are concentrated in narrow stretches of the divinatory calendar and the reason for this.

The fact of the association can be demonstrated graphically. Figure 13.2 lays out the dates in the divinatory calendar on which lunar eclipses were visible in Mesoamerica during the first katun in the sample. During this particular period (7.13.0.0.1–7.14.0.0.0) there were eclipses on days 49, 54 (twice), and 58; one each on days 132, 142, 143, 147, and 150; and one each on days 220, 225, 227, 232, and 236.

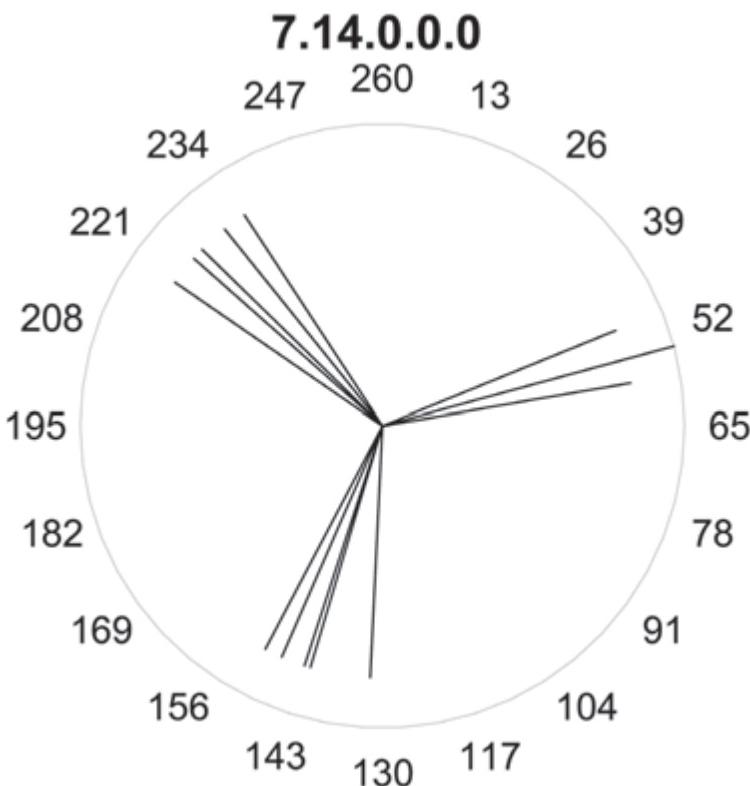


FIGURE 13.2. Dates in the divinatory calendar on which lunar eclipses were visible in Mesoamerica from 7.13.0.0.1 to 7.14.0.0.0. Lines indicate the date in the divinatory calendar of every eclipse of magnitude 0.25 or greater during this katun. The correlation of lunar eclipse nights with the long count is based on subtraction of 584,284.4 days from the Julian Day Number of the eclipse; this has the effect of putting all hours during which a lunar eclipse can be observed on the same day of the divinatory calendar. Numbers surrounding the circle mark the final day of each trecena (13-day unit) in the divinatory calendar. The line extending to the edge of the calendar circle represents the occurrence of two eclipses on the same day of the divinatory calendar, 2,600 days apart; all other lines represent a single lunar eclipse as having occurred on the indicated date. (Graph created by Adam Gordon using the R programming language.)

The point to notice is that eclipses occur in restricted zones, a third of a 260-day calendar cycle apart. To follow this in the figure: going forward in time from the middle of one of these zones, you pass through the next

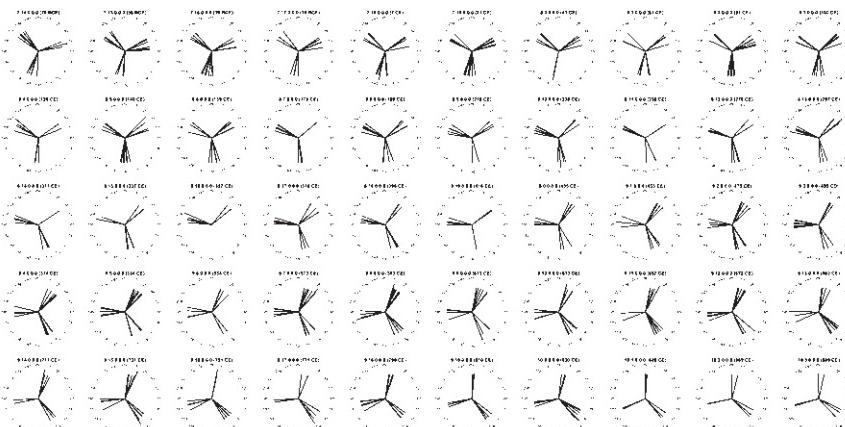


FIGURE 13.3. Recession of lunar eclipses in the divinatory calendar over a period of 50 katuns. Each image graphs the dates in the divinatory calendar of every lunar eclipse of magnitude 0.25 or greater during a single katun, in the same format as in figure 13.2. Given the scale, seemingly thicker lines are actually distinct lines that represent separate eclipses a day or two apart in the divinatory calendar. The first katun of eclipses took place during the 20-year period that ended on 7.14.0.0.0 (78 B.C.); the fiftieth took place during that ending on 10.3.0.0.0 (A.D. 889). Scanning across rows shows how slowly eclipse dates shift in the divinatory calendar, katun by katun; scanning down the rows shows the gradual shift over a 10-katun period. (Graphs created by Adam Gordon using the R programming language.)

eclipse-possible zone of the divinatory calendar after about 86 days, but with no eclipses occurring; continuing another 173—about 173 so far—you arrive in the middle of another zone in which eclipses may again be seen. Going forward another 173 days, you pass the zone of the original eclipses, with none occurring this time, and on to the remaining zone of eclipse-possible dates; finally, in another 173 or so days you have returned to the first narrow band of dates within which eclipses can again occur. As the equation indicates, it takes two passes through the divinatory calendar—520 days—before eclipses recur in the same part of the calendar.

Figure 13.3 displays the dates of all lunar eclipses in the sample during the 50 katuns from 7.13.0.0.0 to 10.3.0.0.0 (98 B.C. to A.D. 889; this excludes thirteen earlier and thirteen later eclipses in the 1,000-year sample). The figure illustrates how concentrated the dates of total lunar eclipses are in the divinatory calendar over the working life of a Mesoamerican daykeeper; how slowly they drift over time through that calendar; and that they recede in the

calendar, falling very gradually earlier with each passing katun. Comparing the situation in the latest diagram with that 1,000 years earlier, it can be seen that eclipses drifted about halfway toward the next earlier zone of eclipse dates (see “Shorter Recurrence Intervals within 11,960-Day Cycles” below and figure 13.12 for further detail).

The reason for this restricted pattern of eclipse occurrence in the divinatory calendar is obvious and well understood (Teeple 1931, 90): the nodes fall very close to their long-term average distance of just under 173 1/3 days apart, and three of these cycles virtually coincide with two passes through the divinatory calendar:

$$3 \times 173.30906 = 519.92718 \approx 520 = 2 \times 260$$

DID MESOAMERICANS ATTRIBUTE SPECIAL SIGNIFICANCE TO RECURRENCES OF ECLIPSES IN SACRED TIME?

The calendrics of eclipse recurrence was probably professional and perhaps secret knowledge; possibly for this reason, we have little evidence about how Mesoamericans discussed the recurrence of eclipses in the divinatory calendar. We gain some insight from statements in two colonial calendrical almanacs that were confiscated from northern Zapotec calendar specialists in charge of sacrifices and divination in their respective towns; however, these documents were among 103 that were confiscated by civil authorities in connection with forced communal confessions and renunciation of idolatry in 1704–1705. (Results here are summarized from Justeson and Tavárez 2007 and Tavárez and Justeson 2008.)

Almost all of the confiscated almanacs in this corpus lay out the divinatory calendar completely, day by day, with each page usually displaying one full *trecena*. Typically, some lines are supplied with annotations in Zapotec; these mostly give something like “the luck of the day” in a four-day cycle. Sometimes other sorts of annotation are added—mostly in Zapotec, sometimes in Spanish, or in both languages.

One of the longest of these annotations (see figure 13.4) refers to two eclipses visible in Zapotec country. It is laid out in two adjacent segments. The first segment is aligned in the calendar with the day name 2 Jaguar; it refers to a total eclipse of the moon that took place on that day, using a widespread Mesoamerican expression (“the moon got eaten”) for such events. The second segment of the annotation is aligned with the day name 5 Earthquake, three days later in the calendar. It states that a total eclipse of the sun had previously occurred on a date in the Spanish calendar that turns

<i>yag-gee</i>	<i>i lax x-</i>	
= yolabi	= x-	
= yoxina	= x-	
= galaxo	= x-	
= quayxoh	= x-	
= quaypa-b	= x-	
= tilafag	= x-	
= las b	= x-	
= ojchila	= x-	

*yo.l=atzi miercole tza niga bi-t-ago beyo bi-sabi +ni
21 enero año de 1693*

2 Jaguar Wednesday. On this day, the moon got eaten.
It floated in the air. January 21, year of 1693.

*yo=xoo tza Jueve go-y-ayi go=bitza sanero
23 agosto año de 1692 [sic]*

5 Earthquake On the day Thursday, previously, the sun burned
(out). August 23, year of 1691.

FIGURE 13.4. Annotation from folio 3r, Calendar 82, AGI Mexico 822.

out to be that of a Zapotec day 5 Earthquake, but one that preceded the 2 Jaguar date by 517 days; it refers to the eclipse using an expression (“the sun burned [out]”), documented to my knowledge only in Zapotec languages (including Northern Zapotec: Long and Cruz 1999, 107). The path of totality of this eclipse had crossed right through Zapotec territory (Espenak and Meeus 2006, A439).

The discourse pattern in this annotation parallels that of the La Mojarra text: the second statement mentions the earlier event, treating it as providing a context for the later, but previously mentioned, event. It suggests that a Zapotec calendar specialist was drawing on presupposed background knowledge—knowledge that was expected to be understood and was therefore used without being overtly stated. I suggest that what the daykeeper understood is that observed solar eclipses are frequently (empirically, more than 40 percent of the time) followed after about 517 days by a visible lunar eclipse. If this is correct, then the daykeeper interpreted the lunar eclipse of 2 Jaguar as having been presaged by the earlier, solar eclipse on 5 Earthquake; the possible appearance of a lunar eclipse was anticipated.

There is evidence that some Zapotec daykeepers were deliberately avoiding overt statements about this knowledge. The page illustrated in figure 13.5 comes from a calendar containing nineteen legible Spanish/Zapotec date correlations. The form of the reference in the illustrated page—the mention in Spanish of a saint’s feast day—was a covert way of calling attention to the date as one of special significance in the *indigenous* calendar. This was true, in one way or another, of all of the Spanish annotations except for one pertaining to Christmas and another to New Year’s Day (Tavárez and Justeson 2008). The annotation illustrated here corresponds to November 29, 1686. What the annotation does not make explicit is that this is the date of a partial lunar eclipse that was visible in Oaxaca, of magnitude 0.5126 (Espenak and Meeus

21 Chalchina
 22 Habacu
 23 Cuatlaguia [sic] Quatac Pab-
 24 [unclear]
 25 Tlalna [unclear]
 26 Na Naoh

Cualagniça 29 nobiembre sabado [sic] sa gregorio
 6 Water 29 November [1686];
 (feast of) San Gregorio (Taumaturgo)

FIGURE 13.5. Annotation from folio 6v, Calendar 63, AGI Mexico 882.

2006; “magnitude 0.5126” means that, at its maximum, 51.26 percent of the moon’s face was in the earth’s umbral shadow).

Eighteen of these annotations refer to dates in the four and a half years between June 1691 and December 1695, but the eclipse date in the figure goes back to 1686. Why this back reference? My guess is that it is because it pre-saged another partial lunar eclipse, of January 11, 1694, which did take place during the 1691–1695 era of this document’s annotations. The 1694 eclipse occurred either on 6 Water—the very same day in the divinatory calendar as the eclipse of November 1686—or the day before, depending on when the divinatory calendar date changed.

Several eclipses were visible in Zapotec country from June 1691 to December 1695. Most were more impressive than that of January 1694, whose magnitude was only 0.2444 (Espenak and Meeus 2006), yet none is reflected among the other eighteen Spanish annotations in Calendar 63. It therefore seems to be the *recurrence* of an eclipse, on or near the same date in the divinatory calendar, that was significant to the daykeepers.

It may have been specifically significant to the writer of the annotation that the interval of 2,600 (= 5×520) days is the shortest that can separate two lunar (or two solar) eclipses that occur on the same divinatory calendar date. In this respect this record partially parallels that of the solar/lunar eclipse pairing of 1691 and 1693, separated by 517 days. An interval of 515 to 518 days is the shortest that can separate two eclipses (one of them lunar and one solar) in the same general part of the divinatory calendar—though such eclipse pairs never occur on precisely the same day.

ECLIPSE RECURRENCE IN PRECOLUMBIAN MESOAMERICA

The colonial Zapotec data suggest that eclipse recurrences in the divinatory calendar had a special significance to at least some Mesoamerican daykeepers. The nature of this significance may have varied among Mesoamerican societies. I have previously argued (Justeson 1989, 83–85) that a nearly complete

eclipse table with a structure like that of the Dresden Codex could be compiled in the working life of a single daykeeper—by projecting solar eclipses at new moons that are within a couple of days of the same divinatory calendar date as a currently observed eclipse, solar or lunar. This section explores the possibility that *exact* recurrences of eclipses in the divinatory calendar could have played a role in Mesoamerican thinking about the timing of eclipses and could have structured procedures for investigating the issue.

This possibility raises two issues: whether exact eclipse recurrence in the divinatory calendar was frequent enough for daykeepers to have engaged with it at more than a casual level; and whether exact recurrences exhibit temporal patterning prominent enough to be recognized and made explicit. This section shows that both questions must be answered in the affirmative. The subsection on shorter recurrence intervals shows further that different multiples of 520 days come into play in patterned ways, sequentially and in relation to one another; this could have influenced daykeepers' thinking and specifically their development of a calendrical model for eclipse prediction. The concluding section shows that the use of one exact recurrence interval, together with one approximate recurrence interval, together are sufficient to provide a fully adequate framework for making reliable eclipse predictions.

In the remainder of this section, the term *eclipse recurrence* refers to the occurrence of a lunar eclipse on the very same day of the divinatory calendar as a previous lunar eclipse (thus also, "eclipses recur," etc.).

In the current study, attention is restricted to partial and total lunar eclipses visible in southern Mesoamerica. It is restricted in these ways for the following reasons. First, only eclipses visible to them could be used by daykeepers to develop a calendrical model for the occurrence of eclipses. Second, lunar but not solar eclipses are visible frequently in a region the size of Mesoamerica, enough so for daykeepers to have developed a calendrical model for their timing; solar eclipses are seen less often from any particular location, and their chronological patterning in the divinatory calendar is almost identical to that of lunar eclipses (see "Synthesis, Conclusions, and Further Directions" below), so observations of lunar eclipses suffice to predict solar eclipses as well. Finally, lunar eclipses are total when the moon falls completely within the earth's umbra (the dark central shadow of the earth), partial when less than 100 percent of the moon's face falls within the umbra, and penumbral when the moon's face falls only within the penumbra, the broader but weaker part of the earth's shadow in which part of the sun's light falls on the moon's face. Penumbral eclipses are only barely visible to trained observers with the naked eye, and then only when the moon's disk is well within the penumbra (Meeus 1991, 353).

Based on the eclipse maps provided by Espenak and Meeus, I judge 225 total and 531 partial eclipses to have been underway while the moon was visible in Mesoamerica during the 1,000 years from 100 B.C. to A.D. 900; note 3 provides the complete listing.

Because partial eclipses with little enough of the moon's face in the umbra are nearly as difficult to observe as a penumbral eclipse, partial eclipses with the lowest magnitudes cannot be assumed to have been noted by Mesoamerican daykeepers, even on evenings when a lunar eclipse may have been anticipated as a possibility. On the other hand, trained observers can detect even relatively low magnitude partial eclipses. The colonial Zapotec eclipse recurrence of Calendar 63—if I am correct in interpreting the significance of the 6 Water date as such—is helpful in suggesting that a partial eclipse with an umbral magnitude at least as low as 0.2444 was noted by Mesoamerican daykeepers. This study is therefore based on the 636 lunar eclipses of magnitude 0.25 and greater.

It is plausible that many of the 123 partial eclipses excluded from this study would also have been observed. Investigation of the full set of partial and total eclipses reveals no patterns of eclipse occurrence that are qualitatively different, however, from those reported in the remainder of this study.

FREQUENCY AND TIMING OF ECLIPSE RECURRENCE

Based on the data in the sample, eclipse recurrence in the divinatory calendar was extremely common in ancient Mesoamerica. Of the 636 eclipses in the sample, all but 31—more than 95 percent—are followed by another on the same divinatory calendar date. The 1,095 intereclipse intervals are exact multiples of 520 days⁶—on average about one per year over 1,000 years. The mathematical structure of the attested multiples of 520 days is tightly constrained, each multiplier of 520 days being of one of the following four forms:

$$5 + 23(n-1) \quad 13 + 23(n-1) \quad 18 + 23(n-1) \quad 23n$$

Expressed in days, each recurrence interval is a multiple of 11,960, optionally with an increment of 2,600, 6,760, or 9,360 days.

Table 13.1 presents the frequency distribution for the full set of recurrence intervals in the sample, displayed in terms of these groups; those that are not multiples of 11,960 days are discussed in “Shorter Recurrence Intervals within 11,960-Day Cycles” below. Figure 13.6 represents these data in a more visually accessible way, as a bubble graph, with frequency proportional to the area of the circle centered on the data point.

TABLE 13.1. Frequency Distribution of Mesoamerican Lunar Eclipse Recurrences in the Divinatory Calendar, in Order of Interval Size, over a Period of 1,000 years (100 B.C. to A.D. 900)

n	$9.8\%5+23(n-1)$	$4.5\%13+23(n-1)$	$33.6\%18+23(n-1)$	$52.1\%23n$
<i>Frequencies of multiples of 520 days</i>				
1	39	1	52	168
2	2	0	51	92
3	11	0	29	68
4	20	2	9	65
5	22	11	42	51
6	11	10	28	34
7	0	7	11	33
8	2	5	28	36
9	0	3	45	15
10	0	4	51	7
11	0	1	13	1
12	0	3	2	0
13	0	2	6	1
14	0	0	1	0

The graph makes it clear that, unsurprisingly, a low average deviation of the recurrence interval from an exact multiple of 520 days correlates very strongly with the frequency of that interval; it is almost tautological that the closer the commensuration between the lunation (29.53059 days) and the 520-day cycle, the more often will full moons recur on same day of the 520-day cycle. Inspection of figure 13.6 suggests a possible second factor, the length of the recurrence interval: of the sixteen intervals with twenty-five or more occurrences, the three with average deviations of more than a day are among the four shortest attested recurrence intervals. Most of these eclipse recurrences turn out to be side effects of a pattern of co-recurrence of eclipses at 2,600- and 9,360-day offsets from multiples of 11,960 days (see “Shorter Recurrence Intervals within 11,960-Day Cycles” below). That eclipses so regularly recurred at the same stations in sacred time must have made a serious impression on Mesoamerican daykeepers and may have provided them a conviction that they were capturing something essential about the cosmos.

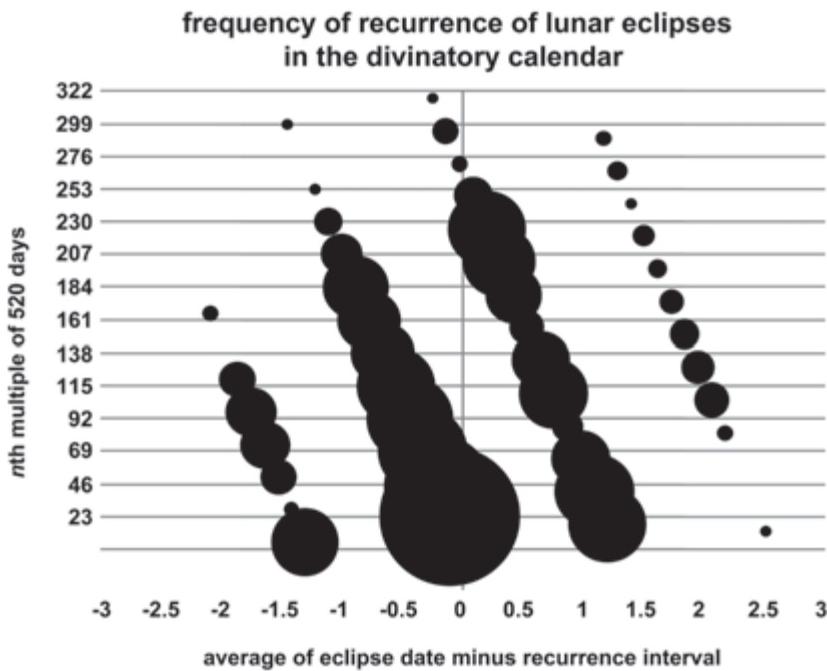


FIGURE 13.6. Frequencies of eclipse recurrences in the divinatory calendar. The aligned series, from left to right, are for multiples of 520 days of the form $11,960(n-1) + 2,600$ (days); $11,960n$; $11,960(n-1) + 9,360$; and $11,960(n-1) + 6,760$.

THE 11,960-DAY INTERVAL

The interval of 11,960 ($= 23 \times 520$) days emerges quite clearly from the data of table 13.1 as an organizing principle for eclipse recurrence—indeed, as the most significant period for structuring an overall eclipse theory on the basis of eclipse recurrence.

1. Over the 1,000 years that were assessed, far more lunar eclipses recur after 11,960 days than after any other multiple of 520 days: 168 lunar eclipses—26.4 percent of the sample—are followed by another exactly 11,960 days later.⁷
2. The 11,960-day interval is more compelling than any other recurrence interval in that its occurrences relative to those near but not on an exact multiple of 520 days is much higher and its spread is smaller (figure 13.7).
3. Long term, more than half of the recurrence intervals among lunar eclipses equal either 11,960 days or an exact multiple of that span. In

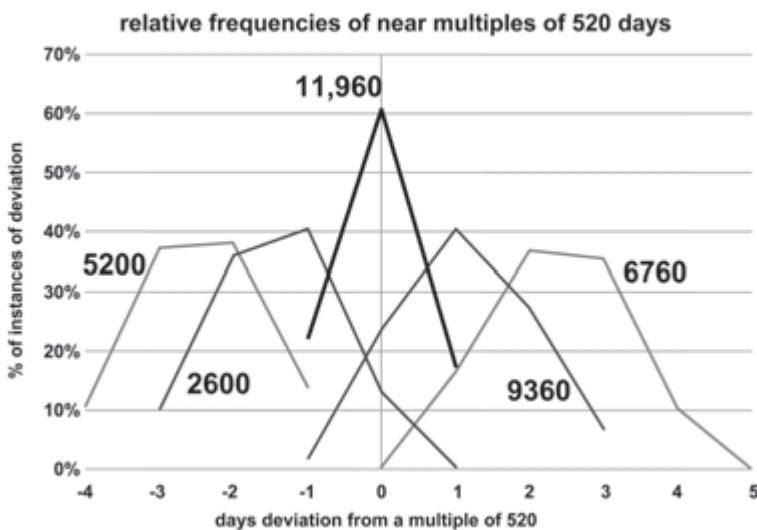


FIGURE 13.7. Frequency distributions of near-multiples of 520 days as intereclipse intervals in Mesoamerica, 100 B.C.–A.D. 900.

a 40-year (or 33-year) career, the 11,960-day interval would account on average for more than 64 percent of the recurrence intervals that that daykeeper would experience.

4. Every eclipse interval that joins two instances of the same divinatory calendar date is either a multiple of this interval or is greater by 2,600 (5×520), 6,760 (13×520), or 9,360 (18×20) days. No other multiple of 520 days shows a comparable performance, and there are, for example, no eclipses at higher multiples of 2,600, 6,760, or 9,360 days except those few that are also multiples of 11,960 days.

Given these properties, and given that thinking in terms of the divinatory calendar is a fundamental element of Mesoamerican daykeepers' problem-solving procedures, it seems almost unavoidable that they would have taken special note of this interval and that it would play a prominent role in the Mesoamerican organization of eclipse theory. Two other lines of evidence support this view.

Mayanists have long known the 11,960-day interval as the length of the eclipse table of the Dresden Codex. One of the basic principles of the organization of astronomical tables in that document is that every astronomical cycle—the synodic cycle of Venus, the synodic cycle of Mars, and the timing

of eclipses—is commensurate with the divinatory calendar. In the abstract, an interval of 11,960 days is the most accurate short-term commensuration of eclipse occurrence with the divinatory calendar; empirically, the frequency and structural role of 11,960 days and its multiples in eclipse recurrence in the divinatory calendar is plausibly the direct basis for its role in framing eclipse stations in the Dresden table.

Although this interval looms large in calendrical eclipse recurrence, it does not yield an especially accurate estimate for the length of a lunation: as a ratio of 11,960 days to 405 lunations—which reduces to a ratio of 2,392 days to 81 lunations—its accumulating error is about 10.6 times larger than that of the much shorter and optimal estimate (Lounsbury 1978, 775) of 1,447 days to 49 lunations. This ratio of 11,960 days to 405 lunations is nonetheless known to have been used in lunar reckonings at Palenque (Teeple 1931, 88–90) and—commensurated with the 18-month calendrical system of lunar semesters (Linden 1986; Schele, Grube, and Fahsen 1992; Cases Martín et al. 2004)—in the recently discovered 4,784-day table of 27 lunar semesters at Xultun (Saturno et al. 2012; Bricker et al. 2014; $4,784 = 2 \times 2,392$). Lounsbury (1978, 799) showed that the dates of eclipse stations in the Dresden Codex agree more closely with calculations using this ratio than with observational averages among eclipse intervals; they also agree more closely with this ratio than with the more accurate ratio of 1,447 days to 49 lunations. The straightforward conclusion is that the 2,392- and 4,784-day subintervals of the 11,960-day cycle were used in Mayan lunar theory and computation precisely because the 11,960-day cycle was significant within Mayan eclipse theory.

SHORTER RECURRENCE INTERVALS WITHIN 11,960-DAY CYCLES

The previous section shows that the 11,960-day span was a key interval for daykeepers to investigate eclipse recurrence and suggests that it is likely to have had some theoretical significance within Mesoamerican eclipse theory. The recurrences that would seem most likely to have been understood in its terms and to have been the primary remaining focus of attention are those that occur at some multiple of 520 days after and before a pair of stations that are separated by that “governing” interval. To some extent this is verified by the data of table 13.1, which show that every eclipse recurrence at other than a multiple of 11,960 days occurs at a station 2,600, 6,760, or 9,360 days into such a cycle. There are other multiples of 520 days that approximate an attested eclipse interval, but no other exact multiple of 520 days is attested, in the 1,000 years of the sample, as a span separating visible eclipses.

The least effective of the subintervals is that of 6,760 days. There is only one eclipse in the 1,000 years of the sample that is followed by another exactly 6,760 days later;⁸ more generally, the recurrences after $11,960(n-1) + 6,760$ days account for only 4 percent of the recurrence intervals. The average departure of this class of interval from a multiple of a lunation starts out by far the worst of the lot, so there are no further recurrences at this subinterval until into the fourth multiple of 11,960 days. Only in and after the sixth multiple of 11,960 do intervals of $6,760 + 11,960 \times (n-1)$ match any other in frequency.

The 2,600-day cycle is only the eleventh most common recurrence interval among the forty-four that are attested, and intervals 2,600 days into an 11,960-day cycle account for fewer than 10 percent of all recurrence intervals in the data. In spite of this, it stands out as the shortest possible recurrence interval in the divinatory calendar, and it is the only exact recurrence that may be reflected in the colonial Zapotec calendars discussed above. Anticipating approximate recurrences within a few days of 2,600 was probably the most important use of the divinatory calendar in daykeepers' eclipse prediction practices; see "Synthesis, Conclusions, and Further Directions" below.

In contrast to the 2,600- and 6,760-day subintervals, stations 9,360 days into an 11,960-day cycle are quite common: they account for more than 32 percent of eclipse recurrence intervals, second only to the 11,960-day multiples. They are attested within every multiple of 11,960 days for which any other recurrence is attested, and they persist longer than the 11,960-day multiples. In fact, during the sixth 11,960-day multiple, recurrences offset by 9,360 days become about as common as the upcoming (sixth) multiple of 11,960 days, and thereafter their frequencies generally exceed those of the 11,960-day multiples. The fact that the 9,360-day subinterval is the only multiple of 520 days occurring in the eclipse table of the Dresden Codex (the fourth station on p. 55b) perhaps relates in some way, empirically or conceptually, to its far greater frequency among the three subintervals.

The outstanding performance of this subinterval of the 11,960-day interval can be understood in terms of the average departures of the subinterval of 9,360 days from the lunar cycle (table 13.2). This departure becomes smaller with each successive 11,960-day interval; is always less than that of the other two subintervals within the same 11,960-day cycle; is comparable to that of the 11,960-day multiple in the sixth pass, when the frequencies of the two become roughly equal; and thereafter is the smallest of any interval. At the same time, the multiples of 11,960 days become increasingly discrepant and less frequent.

For understanding *patterns* of eclipse recurrence, it is significant that the 2,600- and 9,360-day intervals are complements with respect to the governing

TABLE 13.2. Departure of Lunar Eclipse Recurrences in the Divinatory Calendar from Average for the Corresponding Lunation Multiples (structured as in table 13.1)

n	<i>Departures of 520-day multiples from lunations</i>	$5 + 23(n-1)$	$13 + 23(n-1)$	$18 + 23(n-1)$	$23n$
1	1.31		-2.51	-1.20	0.11
2	1.42		-2.39	-1.09	0.22
3	1.53		-2.28	-0.97	0.33
4	1.64		-2.17	-0.86	0.45
5	1.75		-2.06	-0.75	0.56
6	1.87		-1.95	-0.64	0.67
7	1.98		-1.84	-0.53	0.78
8	2.09		-1.73	-0.42	0.89
9	2.20		-1.61	-0.31	1.00
10	2.31		-1.50	-0.19	1.12
11	2.42		-1.39	-0.08	1.23
12	2.53		-1.28	0.03	1.34
13	2.65		-1.17	0.14	1.45
14	2.76		-1.06	0.25	1.56

period; that is, they add up to the 11,960-day recurrence interval within which other recurring patterns might be sought. Because of this, and the nearly perfect commensuration of the 11,960-day governing period with lunar averages, the discrepancies of each from a multiple of 520 days nearly cancel: 88 lunations are on average 1.31 days short of 2,600 days, and 317 lunations average 1.20 days longer than 9,360 days.

Given the high frequency of eclipse recurrence after 11,960 days and the roughly balancing departures from intereclipse averages of these two intervals, one expectable pattern is triples of eclipses on the same date, where the first recurrence is after 2,600 days and the second after 9,360, or vice versa, thus:

eclipse—2,600 days—eclipse—9,360 days—eclipse

or

eclipse—9,360 days—eclipse—2,600 days—eclipse

TABLE 13.3. Relative Placement of 2,600- and 9,360-Day Intervals among Lunar Eclipses for the Divinatory Calendar Dates on which Lunar Eclipses Recur

<i>i6</i>	<i>212</i>	<i>199</i>	<i>207</i>	<i>12</i>	<i>41</i>	<i>107</i>	<i>191</i>	<i>203</i>	<i>215</i>
11,960	11,960	11,960	21,320	2,600	2,600	11,960	11,960	36,880	9,360
11,960	42,640	11,960	23,920	9,360	11,960	11,960	26,250	2,600	2,600
11,960	2,600	23,920	11,960	11,960	69,160	83,720	9,360	9,360	45,240
23,920	9,360	2,600	26,520	11,960	9,360	9,360	47,840	47,840	38,480
2,600	11,960	9,360	9,360	23,920	2,600	2,600	9,360	11,960	9,360
9,360	11,960	47,840	11,960	11,960	21,320	9,360	11,960	11,960	11,960
11,960	23,960	9,360	11,960						
		2,600							
		11,960							

Three of these instances consist of four eclipses, all in the following sequence:

eclipse—9,360 days—eclipse—2,600 days—eclipse—9,360 days—eclipse

These patterns are found throughout the data. In twenty-one of the thirty-nine instances of eclipses separated by 2,600 days, an eclipse follows or proceeds at a distance of 9,360 days. In fact, the most common successive sequence of recurrence intervals, apart from two cycles of 11,960 days, is of 2,600 days followed by 9,360 days.

When there are few instances of a given divinatory calendar date, the postulated tendency for these intervals to occur in direct succession could be a chance effect; it is important to investigate this phenomenon among divinatory calendar dates that occur most frequently, so that there will be many other multiples of 520 days among which these two intervals might chance to fall. Table 13.3 lists the ten divinatory calendar dates on which eclipses recur most often, along with the number of days between their successive occurrences as eclipse dates. Eight of these ten have intervals of both 2,600 and 9,360 days between successive instances of eclipses. Among them, days 12, 16, and 203 have just one of each of these intervals, and for each of them these eclipse intervals occur in immediate succession. The other five of these eight dates have two instances of one interval and one of the other, and every one of them has either a 2,600- and 9,360-day or a 9,360- and 2,600-day interval sequence (one has both). Note that most of the other intervals are 11,960 days or multiples of that interval.

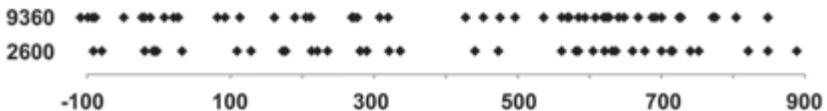


FIGURE 13.8. *Temporal distribution of 2,600- and 9,360-day recurrences among Mesoamerican lunar eclipses, 100 B.C. to A.D. 900.*

Another 21 days have six eclipses and five intereclipse intervals; four of them (days 8, 17, 99, and 138) have exactly one interval of 2,600 and one of 9,360 days; for these dates too, the intervals occur in direct succession.

Considering all these cases together, the probability of this extent of adjacency of the 2,600- and 9,360-day intervals among day names in which both intervals occur, assuming all sequences of intervals are equally likely, is less than 1 chance in 26,000. A Mesoamerican model for eclipse prediction provides a straightforward account for this pattern (see “Synthesis: Eclipse Families in the Divinatory Calendar” below).

The systematic tendency for a 2,600-day recurrence to be preceded and/or followed by a 9,360-day recurrence is reflected by a close linkage between the timing of eclipses at these intervals throughout the 1,000-year sample. This is reflected visually in figure 13.8 by the corresponding positions of the larger gaps among occurrences of each interval, with those among the 2,600-day intervals typically beginning somewhat later than those among the 9,360-day intervals—in spite of the fact that there are more 9,360-day intervals overall.

DATA FOR MODEL BUILDING: THE TRIPLE CYCLE OF $3 \times 11,960$ DAYS

What kinds of data, and how much, was available for theory or model building in terms of the 11,960-day cycle and its multiples?

The availability of these intervals for the considerations of daykeepers varies substantially over time. On average, 3.4 eclipses per katun recur after this interval.

A series of overlapping 11,960-day intereclipse intervals completely covers the 1,000-year span of Mayan history from before the first display of the long count to around A.D. 900. There were always at least two 11,960-day intereclipse intervals in progress at any time; this minimum happened just once, from the eclipse of May 30, 774, until that of September 11, 778. Thirteen overlapping 11,960-day intereclipse intervals, the maximum number, were simultaneously underway from the eclipse of February 23, 639, until that of August 19, 639. (If intervals of 11,959 and 11,961 days are included, as many as seventeen and no fewer than three are current at any one time during this span.)

The time between two successive eclipses that are both followed by another 11,960 days later ranges from as low as 176 days to as high as 11,783 days. Of the 168 eclipses that are followed by another at this interval, 120 (71.4 percent) are separated from one another by fewer than 2,600 days. The most senior daykeepers—those active for thirty-five years or more—would see several such recurrences during their careers.

As many as five successive lunar eclipses are followed by another exactly 11,960 days later. Conversely, as many as seventeen successive lunar eclipses are *not* followed by another at this interval.

A single eclipse can be followed by four others at intervals of 11,960, $2 \times 11,960$, $3 \times 11,960$, and $4 \times 11,960$ days; that is, as many as five lunar eclipses can occur in succession at intervals of 11,960 days (with other eclipses intervening).

Given the salience of the 11,960-day interval, daykeepers might have sought insight about eclipse timing, especially in longer sequences consisting of several complete 11,960-day intervals, each of which ends with the recurrence of a lunar eclipse. Figure 13.9 graphs the number of Mesoamerican lunar eclipses that recur in the divinatory calendar after the n th multiple of 11,690 days. Intuitively, it seems plausible that spans that run to higher multiples of the 11,960-day period should be more highly constraining, or constrained, with respect to the pattern of occurrence of eclipses within the constituent 11,960-day intervals, than is an arbitrary span of 11,960 days; this would be expected because the attestation of the 520-day multiples plausibly depends both on the average days of discrepancy between the multiple and the lunation, and on the distance of the eclipse from the nodes. Statistically, however, there is scant evidence for such a constraint. In these data the probability of a recurrence after 11,960 days is about one-third greater among eclipses that have a recurrence after $3 \times 11,960$ days (35.4 percent: 23 of 65) than among those with no such recurrence (26.7 percent: 145 of 544); however, the difference is not statistically significant ($p = 0.137$).

Nonetheless, given the salience of the 11,960-day interval, daykeepers might have paid special attention to eclipse recurrences at successive multiples of this interval (the concluding section provides evidence of a specific role for it). The remainder of this section characterizes the available data. The sample includes 168 lunar eclipses that are followed by another after exactly 11,960 days; 26 of these pairs are followed by yet another eclipse after another 11,960 days, thus with recurrences at two successive 11,960-day intervals; and there is one series of five successive eclipses, with four successive 11,960-day recurrences. There are no longer unbroken sequences of this sort. There are longer sequences of eclipses at multiples of 11,960 days, however, in which all but one pair occurred exactly

lunar eclipse recurrences at multiples of 11,960 days

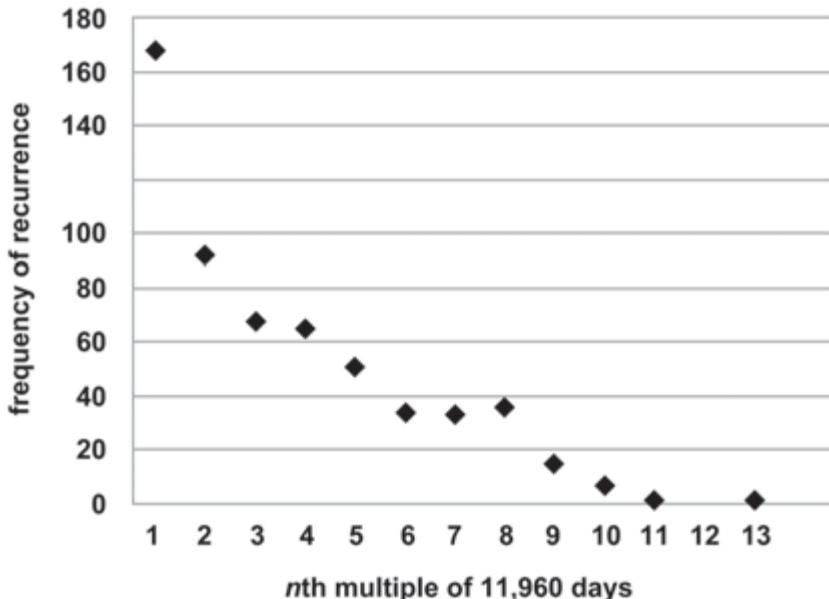


FIGURE 13.9. Distribution of lunar eclipse recurrence at multiples of 11,960 days. The frequency data approximately follow an exponential distribution, with a probability of recurrence (f) of approximately $205.6546 \exp(-0.3045 n)$; $R^2 = 0.9668$.

11,960 days apart, while the remaining pair is separated by $2 \times 11,960$ days. The longest such sequence is of eight eclipses spanning $9 \times 11,960$ days.

Figure 13.10 shows that the nearly maximal unbroken sequences of three successive 11,960-day recurrences were ever-present during the Classic period. It will be noted that there were multiple series of this sort underway concurrently throughout the period that is charted. Because $3 \times 11,960$ amounts to just under five katuns, the number of concurrent series can only be evaluated from five katuns after the earliest such series through five katuns before the end of the last. This constraint is met by series 4 through 14 in the graph. In these series, spanning the interval from A.D. 76 to 765 (8.1.0.0.0 through 9.17.0.0.0), the range of is from two to seven concurrent at any time, and 3.9 at a time on average.

Very long series of eclipses at 11,960-day intervals are likely to be roughly centered with respect to the dates of full moons. Since eclipse recurrences at

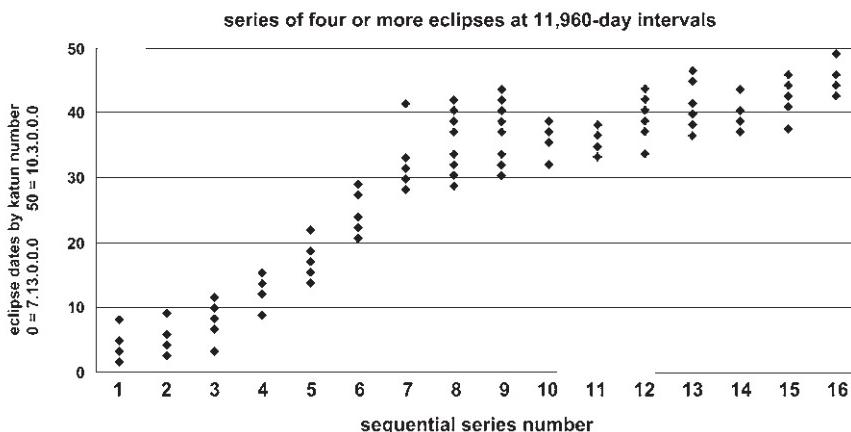


FIGURE 13.10. Sequences of four successive eclipses at 11,960-day intervals. The vertical axis indicates the dates of each eclipse series in the Mayan or epi-Olmec long count, in a correlation in the Goodman-Martínez-Thompson family (GMT variants are not distinguishable at this scale). The horizontal axis designates each eclipse series, ordered by the date of the first eclipse in the series.

2,600-, 5,200-, 6,760-, and 9,360-day intervals deviate quite differently from the average deviations of the corresponding 88-, 176-, 229-, and 317-lunation intervals, exploring the relative placement of these recurrence intervals among eclipses within the sixteen long series is likely to be a useful heuristic device. A much larger body of data with similar relevance, however, was equally available to daykeepers. These sixteen recurrence series are impressive in that all of the eclipses were visible, but any overall constraints relating to the placement of these lunar eclipses with respect to other eclipse-recurrence intervals—which I take to be largely relatable to the size of discrepancies between the return of nodes and the arrival of the full moon—are also present for *any* eclipse pair separated by $3 \times 11,960$ days, and there were 68 such pairs during the 1,000 years of the sample. The dozens of longer recurrence intervals that are multiples of this cycle provide further constraints.

These considerations show both that daykeepers would have had a substantial body of data available to them concerning the internal structure within 11,960-day cycles and that they could have accumulated such data relatively quickly and as needed. Detailed exploration of exact recurrences within the limits of the 11,960- and $3 \times 11,960$ -day cycles does yield systematic restrictions and trends that are revealing for our understanding of eclipse timing among

the stations of the 11,960-day cycle; discussion of such results was part of an earlier draft of this chapter.

It turns out, however, that a reliable procedure for eclipse prediction can be developed from simpler and more common patterns, which are taken up below (see “Synthesis, Conclusions, and Future Directions”). Construction of this procedure requires attention to two broader issues, taken up in the next section. First, concerning the synchronic structure of eclipse occurrence, what was the nature, or what were the units, of their eclipse-region construct? Second, concerning its dynamic structure, what mechanism(s) did they use to adjust that unit as it receded in the divinatory calendar?

DEFINING A MESOAMERICAN NODAL CONSTRUCT

As discussed in the “Background” section and as represented in figure 13.3, there are three relatively narrow zones of the divinatory calendar in which eclipses can occur. Based on the data presented in that figure, in any katun there are no eclipses on most of the divinatory calendar dates between the earliest and the latest in each zone. The same is true over the working life of a daykeeper. The relative placement of these gaps does not seem to repeat consistently or to be offset by a consistent amount in the immediately following katun. So it seems very likely, and certainly plausible, that Mesoamericans entertained each of the three eclipse-possible zones of the divinatory calendar as a continuous span of eclipse-possible days within that zone.

Under such a model, lunar eclipses occur on a full moon within the eclipse-possible period within the divinatory calendar, on alternate passes through that part of the calendar; solar eclipses occur on a new moon that falls in the same period. Provided the period is narrow enough (and it is), this model therefore reduces the problem of solar and lunar eclipse prediction to the separate problem of determining the dates of new and full moons—an issue that is not addressed here—and applying it within the fixed eclipse-possible zones of the divinatory calendar. Our immediate problem therefore becomes the size and placement of these regions. The range of eclipse dates is characterized in this section over a period of one katun, for reasons that are elaborated in “Eclipse Recession in the Katun Cycle” below.

Figure 13.11 plots the earliest and latest divinatory calendar dates during the 7,200 days preceding the date on the *x*-axis; that is, these are “sliding” katuns, not 20-year segments of the long count. The empirical range fluctuates considerably, varying in large part but not exclusively with the number of eclipses that took place during that period. During any 7,200-day span, the maximum

local maxima and minima of lunar eclipses

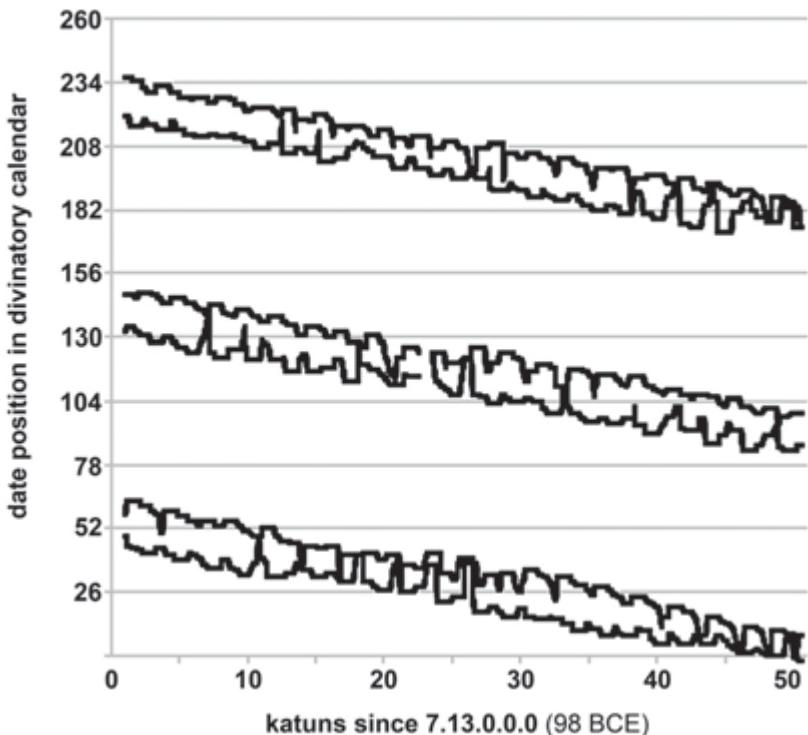


FIGURE 13.11. Range of eclipse dates in the divinatory calendar during the 7,200 days preceding the date over a period of 50 katuns (7.13.0.0.0 to 10.3.0.0.0). The graph begins 7,200 days after the first observed eclipse during the 1,000 years of the sample. Days 258 through 260 are graphed at positions -2 through 0 for continuity.

attested spread of lunar eclipse dates in the divinatory calendar is 26 days; in any given pass through any eclipse-possible zone, there is therefore at most one full moon and one new moon within that zone.

A trio of fixed-length eclipse-possible regions of the divinatory calendar constitutes a Mesoamerican analogue to a node that would structure Mesoamerican thinking about the timing of eclipses: it is a temporal region during which eclipses can occur and outside of which they cannot.

To predict the timing of eclipses in the longer term, it remains to create a model for the recession of that sequence—and of the nodes—in the divinatory calendar. There are distinct solutions anchored in at least two established

Mesoamerican calendrical constructs, the katun and the calendar round. Yet another may have been based on the 11,960-day framework for eclipse occurrence.

ECLIPSE RECESSION AND THE 11,960-DAY CYCLE

Given the prominent role that the 11,960-day cycle would seem to have had in Mesoamerican eclipse theory, it could also have served as a basis for monitoring and ultimately anticipating the rate of recession of the eclipse zone in the divinatory calendar. The long-term average distance between eclipses is 11,959.89 days, so one would not expect any shortening of that specific cycle—or, if so, to 11,959. In 1,000 years, there is no instance of an intereclipse interval of only 11,958 days.⁹ The average *internodal* span over the same interval is 11,958.33 days. As a result, the *spread* of eclipse dates in the table as a whole should recede by an average of 1.67 days, for a whole number recession more often of two days than of one. The Dresden Codex eclipse table records an overall cumulative total of 11,958 days, which could overtly reflect a Mayan estimate of the recession of the eclipse zone as a whole.

In the subsection “The 11,960-Day Interval” above, it is suggested that sequences of four successive eclipses at 11,960-day intervals, or intervals of $3 \times 11,960$ days, could have played a special role for daykeepers investigating the relative timing of eclipse recurrences at diverse intervals. During the 35,880-day span, such sequences, the nodes, and therefore the spread of eclipse dates recede in the divinatory calendar by 5.02 days. Calendar specialists would very likely have been aware of this 5-day difference; if so, it could have been implemented in individual 11,960-day sequences by a repeating triple-cycle of lengths 11,958, 11,959, and 11,958 days.

The effect of this shortening of the cycle therefore matches what would be required to correct the placement of the nodes (which Teeple and Lounsbury argue to have been at the base of the Dresden eclipse table). Why nodal passages and not eclipse dates? Aligned with the recorded stations of the Dresden table are three rows of day names. The base of the table is known from the preface to be the day 12 Lamat, at the end of the third row. Were a second pass to end with this eclipse date, after 11,960 days, it would begin again at the first station on the third row. A second pass starting after 11,958 days would follow the upper row of the day names; a pass starting after 11,959 days would follow the second row.

Nonetheless, this cannot be a way to address the nodes per se because the intervals between stations are eclipse intervals, not internodal intervals, and so

are associated with a fixed point in the lunation—which the 11,960-day interval commensurates. The shortening of the interval should disrupt the proper placement of eclipse stations within it.

As the nodes move relative to the lunation, however, so do their Mesoamerican analogues, the zones of the divinatory calendar in which eclipses occur; each zone is centered on one of three divinatory calendar dates corresponding to a node. While a recurrence of the table's base date after 11,960 days would often correspond to the actual date of an eclipse, eclipses will no longer be able to occur on the very latest divinatory calendar dates in the table. A change from the third row to the second or first might be intended in part to capture, in some fashion, the recession of eclipses in the divinatory calendar—the backward shift of the zone of eclipse-possible dates that is the Mesoamerican daykeeper's analogue to the nodes.¹⁰ The latest of the eclipse dates, in the individual eclipse regions, might in this way have been marked for retirement.

ECLIPSE RECESSION VIA THE CALENDAR ROUND

A model for eclipse recession anchored in the pan-Mesoamerican framework of the calendar round would have suggested a rate of recession of eclipses relative to the divinatory calendar closely similar to that in a $3 \times 11,960$ -day interval, as in a triple pass through the Dresden eclipse table. Epi-Olmecs are almost sure to have been aware of this estimate.

The epi-Olmec CNVC (see “Background” above) commensurates the Venus and eclipse cycles in about 37,955 days:

65 Venus cycles:	37,964.91 days
219 eclipse cycles:	37,964.68 days

Mesoamericanists will recognize here the period of 65 Venus cycles that structures the Venus tables in the Dresden and Borgia group codices, a double calendar round of 37,960 days ($= 2 \times 52 \times 365 = 65 \times 584$). This calendrical cycle approximates the CNVC via the difference between the eclipse cycle and the doubled divinatory calendar cycle.

The structure of the Mayan Venus table, with its “adjustment numbers,” makes it clear that Mayans knew not only the fact of the slippage of the Venus cycle with respect to both the divinatory calendar and the 365-day calendar, but also its general magnitude—somewhat more than 4 days, a good bit less than 8. Thereby, they knew its slippage with respect to the calendar round. Most likely, specialists in all Mesoamericans calendar traditions also knew this.

In the epi-Olmec case, with their commensurating of Venus and eclipse cycles, we would expect them to know not only that Venus events reliably fell five or six days earlier in the divinatory calendar after two calendar rounds but, given the equivalence of 65 Venus cycles with 219 eclipse cycles, that eclipses must do so as well.

A likely reflection of this knowledge survives in the monumental record. Among the six epi-Olmec dates tied to the CNVC, one pair of them is at a nearly exact multiple of the commensuration period. The second station of the CNVC on Cerro de las Mesas Stela 6 differs from that on the La Mojarrá stela by 113,863 days; this is almost exactly three times the commensuration between the Venus cycle and the eclipse cycle:

37,954.91	65 Venus cycles	tripled: 113,864.72
37,954.68	219 eclipse cycles	tripled: 113,864.05

It is presumably coincidental that these particular instances of dates in the CNVC happen to be at a multiple of its full length; there is a 39.6 percent chance that at least one pair out of the six dates in this cycle would have fallen at a multiple of the full cycle. Nonetheless, these records reflect the fact that epi-Olmec calendar specialists, working with dates in this cycle, would have had access to its length—whether the stations they recorded were scheduled calendrically ($113,863 = 37,954 + 37,955 + 37,954$) or by some sort of observation. Given that epi-Olmecs timed most publicly recorded civic actions within this cycle, that the cycle was keyed to the occurrence of eclipses, and that these dates fell on those days in the divinatory calendar on which lunar eclipses occur, they are sure to have known that lunar eclipses recede by 5 or 6 days over the span of 37,960 days. They would probably have known this by A.D. 277, three full CNVC cycles after the earliest recorded example, from 36 B.C., on Chiapa de Corzo “Stela” 2.

It is not obvious that other Mesoamericans would have associated this slippage with the eclipse cycle as well as with the Venus cycle, but certainly it is plausible that they could have done so. Given the diffusion of knowledge relating to the long count between epi-Olmecs and Mayans, it seems likely that Mayans at least knew this as well.

ECLIPSE RECESSION IN THE KATUN CYCLE

For those calendar specialists who worked with the count of katuns—epi-Olmecs and Mayans—there is yet another nearly irresistible answer to the question of how to adjust their model for lunar eclipse occurrence to deal



FIGURE 13.12. Distribution of lunar eclipses, 43 katuns apart. Note that the distribution of eclipses in the divinatory calendar in the graphs of the first row are approximately the inverse of their distribution in the corresponding graphs in the second row, from 43 katuns later.

with the recession of eclipses in the divinatory calendar: they would simply move their eclipse bands earlier—whatever their size—by one day at the end of every katun. For us, this follows from a simple calculation, based on the average departure of three passes through the nodes from the 520-day period:

$$519.92718 - 520 = 0.07282 \text{ rate of recession in 520 days}$$

$$1 / 0.07282 \text{ number of 520-day cycles to accumulate 1 day of difference}$$

$$\begin{aligned} 520 / 0.07282 \text{ days to accumulate 1 day of difference} \\ = 7140.895 \text{ days} \end{aligned}$$

The centers of the eclipse-possible zones in the divinatory calendar, at a particular time, should be separated on average, long-term, by $(1/2) \times 173.31$ days, or 86.65 days (in the 260-day calendar; the zones are 173.31 days apart in real time); it should recede halfway through the calendar after 42.97 katuns. This shift is represented visually in figure 13.12, in which the distributions of eclipses within the divinatory calendar for the first seven katuns are compared with those for the last seven katuns, 43 katuns later: visually, the zones in the later group indeed appear to fall about halfway between those for the earlier eclipses.

The viability of such a model in real time can be verified empirically. Figure 13.11 graphs the earliest and latest divinatory calendar dates in each of the three eclipse zones during the 7,200 days prior to each lunar eclipse. It shows the gradual recession of eclipse dates over time. Because the look-back is limited to only one katun, there are substantial fluctuations in these ranges, but the decline overall is clearly systematic.

The pattern of decline shows more regularity when it is tracked over longer periods. Figure 13.13 graphs, for each eclipse zone, the latest divinatory

lunar eclipse recession in the divinatory calendar

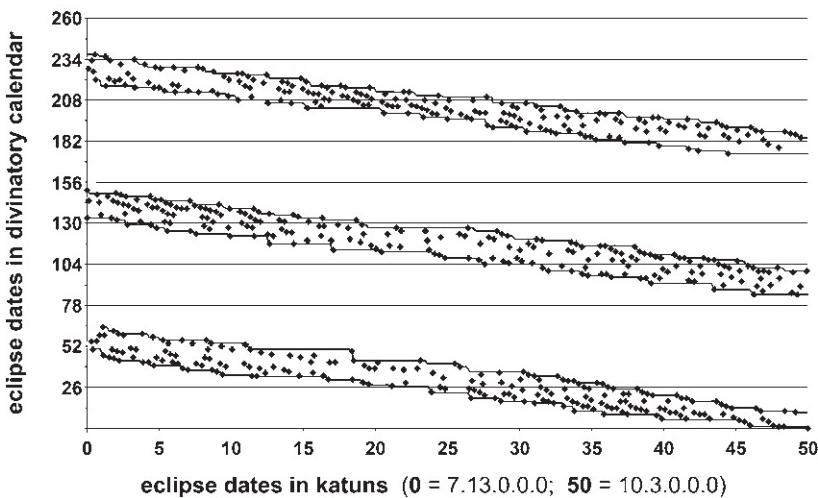


FIGURE 13.13. Decline of long-term maxima and minima in the divinatory calendar of Mesoamerican lunar eclipses over a period of 50 katuns (98 B.C. to A.D. 889).

calendar dates of eclipses no earlier than the current date in linear time, and the earliest divinatory calendar dates of eclipses no later, again across 50 katuns of lunar eclipse records. The calculated recession in the divinatory calendar of 1 day per 7,140.895, or 0.9918 days per katun is confirmed in this representation. From top to bottom, the equations of linear regression for these maxima and minima are as follows:

$$\begin{array}{ll}
 \text{Group 1: } y = -0.9909x + 235.02; & R^2 = 0.9923 \quad y = -0.9936x + 219.21; \quad R^2 = 0.9915 \\
 \text{Group 2: } y = -0.9875x + 149.73; & R^2 = 0.9914 \quad y = -0.9810x + 131.55; \quad R^2 = 0.9925 \\
 \text{Group 3: } y = -1.0445x + 63.33; & R^2 = 0.9823 \quad y = -0.9393x + 44.671; \quad R^2 = 0.9886
 \end{array}$$

where y is the divinatory calendar date and x is the number of katuns between the eclipse date and 7.13.0.0.0. The regression coefficients average -0.989 days per katun, in close agreement with the calculated rate of recession.

This way of tracking eclipse dates, which depends upon long-term record keeping, would make possible a general sense of the rate of recession in the katun. There is a more specific basis for such a calculation. As discussed in “Eclipse Recession and the 11,960-Day Cycle” above, the rate of eclipse recession in the 11,960-day interval was arguably known by the daykeepers

responsible for the eclipse table of the Dresden Codex. This rate we can calculate to have been 5.025 days in $3 \times 11,960 = 5 \times 7,200 - 120$ days—or, equivalently, 1.005 days in $7,141$. Observed historically, this can hardly have been distinguishable from 1 day in $7,200$.

Mayan calendrical astronomers could therefore have operated with a model in which eclipses were thought to recede in the divinatory calendar by one day per katun. The long count, as a cycle of 260 katuns (= 13 baktuns) can be seen as a version of a divinatory calendar whose 260 units are katuns instead of days; given this, a model of recession by one unit in the 260-day divinatory calendar for each unit in the 260-katun long count could have had considerable appeal in Mayan eclipse theory, and perhaps in Mayan cosmology. In particular, a Mayan model would almost surely have estimated that the eclipse cycle would recede through a full 260-day cycle of the divinatory calendar during the 13 baktuns of the long count—which would have been in error by only two days in $5,200$ years.

Figure 13.14 takes this approach further: it represents a model in which, within each katun unit within the long count, there was a fixed set of divinatory calendar dates on which lunar eclipses could occur and in which at the end of each katun the earliest and latest eclipse-possible dates in the divinatory calendar were reduced by one day. Such a model, in which each eclipse-possible region of the calendar contains 26 successive days, would capture all eclipse dates in the 1,000 years of eclipse data examined here. In fact, as the figure indicates, the latest eclipse region in the divinatory calendar encompasses just 21 days, the middle region 26, and the earliest 25. A set of three regions of the divinatory calendar, each encompassing a fixed number of days, would be a Mesoamerican analogue to the concept of a node: a fixed segment of the time continuum in which eclipses can take place.

Between the zones of eclipse-possible divinatory calendar dates are larger regions of the divinatory calendar in which eclipses *cannot* be observed. In the katun-based model, two of these regions span 150 days and one spans 148 days. Because the local maxima and minima of the eclipse-possible zones are closer than those of the katun model calibrated to the full 1,000 years of the sample, observationally the zones in which eclipses are not seen are wider than 148 days. A notable consequence of this result is that visible lunar eclipses are never separated by as little as 148 days (five lunations). Intereclipse intervals of 148 days are well accepted in Mesoamerican studies because they appear as a basic structural feature in the organization of the Dresden Codex. Yet, in the 1,000 years of eclipses monitored in this study, only one lunar eclipse followed another by so short an interval, and its magnitude was only 0.53 percent; it was

lunar eclipse recession in the divinatory calendar: uniform model of one day per katun

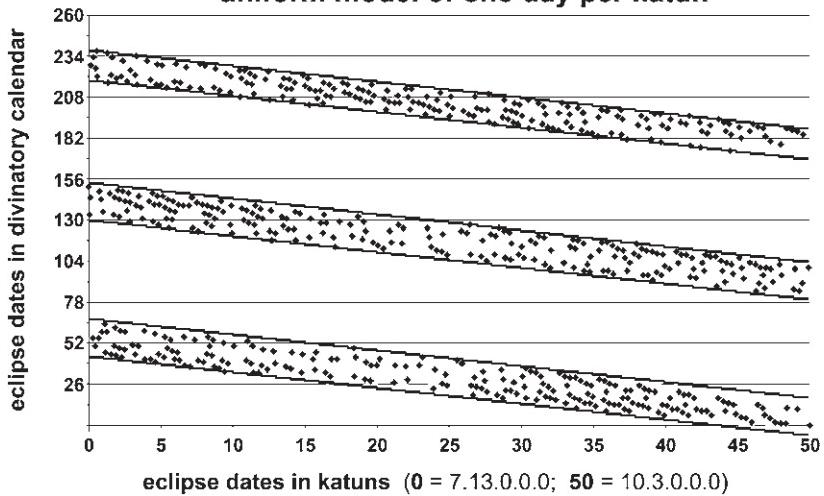


FIGURE 13.14. *Divinatory calendar dates of Mesoamerican lunar eclipses (7.13.0.0.0 to 10.3.0.0.0, by katun). Dark lines are the upper and lower limits of fixed spans that drop back in the divinatory calendar by one day at the beginning of each katun. The dark lines mark the earliest and latest eclipse-possible dates in each eclipse zone. In the eclipse region earliest in the divinatory calendar, the eclipse-possible zone spans 25 days; in the central region, 26 days; and in the latest region, 21 days.*

scarcely more prominent visually than a penumbral eclipse. The roles of the five-month intervals in Mayan eclipse theory, reflected in the structure of the Dresden Codex, requires separate treatment; this is the focus of another study in honor of Anthony Aveni (Justeson 2013).

SYNTHESIS, CONCLUSIONS, AND FURTHER DIRECTIONS

This study builds on the long-established relationship between eclipse occurrence and the divinatory calendar through the near-equivalence of three nodal passages and two cycles through the calendar. It shows that eclipse recurrence in the divinatory calendar was extremely common in ancient Mesoamerica—far more common, I believe, than has hitherto been suspected. About once in 20 months, on average, there was a lunar eclipse in Mesoamerica that followed another on the same day of the divinatory calendar, at some multiple of 520 days apart. Beyond the relationship of eclipse

occurrence to the 520-day interval, these empirically established recurrence intervals were highly structured, in terms of a framework of 11,960 days, along with substations at 2,600, 6,760, and 9,360 days within that framework. This 11,960-day framework is known from the Dresden eclipse table to have been influential in structuring Precolumbian Mayan eclipse theory, and from back-projected lunar records at Palenque and from the Xultun lunar semester table to have been influential in structuring Classic Mayan lunar models generally. Eclipses are frequently observed $3 \times 11,960$ days apart; this interval would have provided a framework for observing and calculating the rate of recession of eclipse dates in the divinatory calendar by daykeepers throughout Mesoamerica.

SYNTHESIS: ECLIPSE FAMILIES IN THE DIVINATORY CALENDAR

A particular set of practices for eclipse prediction, within the framework of the divinatory calendar, can be suggested from the complete record of eclipses of magnitude 25 percent and greater that is displayed in figure 13.14. Attention to the spatial patterning of eclipse dates in each of the three eclipse zones in the figure reveals a recurring pattern associating eclipses that, usually, are *not* separated by a precise multiple of 520 days from one another. What they show is a special subpattern of recession of eclipse dates, one or two days at a time, in “strings” of eclipses—sequences of as many as eight eclipses, with only the scantiest of visual gaps between them in the figure, whose divinatory calendar dates gradually but pretty steadily decrease throughout the string. This pattern is far more pervasive than the exact recurrences and would have been recognized readily by daykeepers.

The most visually striking of these eclipse strings are defined by a drop of at most two days in the divinatory calendar, in close succession. The eclipses in such strings are separated by 0 to 2 days less than 2,600 days, the smallest possible exact recurrence interval; with a small gap, more and longer strings of recurrences can be seen when eclipses are separated by 0 to 3 days less than 2,600 days or by 1 to 4 days less than $2 \times 2,600$ days.

The visual reflection of these intervals in the graph and the number of instances of each are as follows:

2597 30/298	<u>2598</u> 107/298	2599 120/298	2600 40/298
5196 29/244	<u>5197</u> 102/244	5198 104/244	5199 38/244

Two early examples of such strings are displayed in table 13.4, both from near the beginning of the middle zone of eclipse dates in figure 13.14. Table 13.4a lists a series of eight eclipses, separated from one another by about 2,600 days each; the image that heads the list is from the corresponding part of figure 13.14. Table 13.4b lists a string of ten eclipses, mostly separated by about 2,600 days but in two cases by about 5,200 ($2 \times 2,600$) days, again headed by its visual representation in figure 13.14.

Note that several eclipses that are not a part of a given eclipse string almost always intervene in time between the successive eclipses of that string. In figure 13.14 intervening eclipses appear above or below the eclipses within a string; each is part of a different string. In fact, different strings overlap substantially in time. The two that are presented in table 13.4a and b are both from a group of three partly concurrent eclipse strings, from the earliest part of the sample of eclipses, displayed in figure 13.14; these three strings are displayed, in larger format, in table 13.4c.

The strings are a construct involving a selection of eclipses ordered not in linear time but rather in the divinatory calendar: they fall within a couple of days of the same date in the divinatory calendar, mostly at or near the minimum recurrence interval of 2,600 days. The gaps in table 13.4b occur when no lunar eclipse was seen in Mesoamerica 88 months after a previous eclipse (2,598.3 days on average), but one was seen 88 months after that. In point of fact, these gaps *were* the dates of lunar eclipses—eclipses that did not chance to be visible in Mesoamerica or were of magnitude less than 25 percent.

The vast majority of the eclipses in the recession graph (figure 13.14) in fact occur within a string of at least two eclipses, and most often of four or more. Given the frequency distribution above, eclipses separated by these intervals, and therefore the strings, recess in the divinatory calendar at a rate of 1.33 days per 2,600 days, or 3.68 days per katun.

The minimal eclipse recurrence interval of 2,600 days cannot have escaped the daykeepers' notice as a fundamental unit of eclipse theory and prediction. The Colonial Zapotec data already suggest this. More definitively, in the 1,000 years of lunar eclipse data followed here, almost half of the lunar eclipses in Mesoamerica were followed by another eclipse 2,600 *or so* nights later (specifically, 298 of the 630 eclipses that are more than 2,596 days before the last date in the sample). Furthermore, the eclipse families reflect an observational regularity that there are long periods of eclipse repetition every 2,600 days or so, including an occasional gap when a presumably anticipated eclipse does not appear. Successive eclipses in these families would usually (227 out of 298

TABLE 13.4. Three Early Eclipse Families.

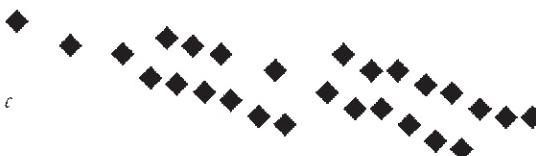
a

7.17.8.2.6 +2598	146	(3 Death)
7.17.15.6.4 +2600	144	(1 Lizard)
7.18.2.10.4 +2598	144	(1 Lizard)
7.18.9.14.2 +2599	142	(12 Wind)
7.18.17.0.1 +2598	141	(11 Cayman)
7.19.4.3.19 +2599	139	(9 Storm)
7.19.11.7.18 +2600	138	(8 Flint)
7.19.18.11.18	138	(8 Flint)

b

7.15.0.0.8 +2599	148	(5 Rabbit)
7.15.7.12.7 +2599	147	(4 Deer)
7.15.14.16.6 +5198	146	(3 Death)
7.16.9.6.4 +5197	144	(1 Lizard)
7.17.3.14.1 +2598	141	(11 Cayman)
7.17.10.17.19 +2600	139	(9 Storm)
7.17.18.3.19 +2598	139	(9 Storm)
7.18.5.7.17 +2598	137	(7 Quake)
7.18.12.11.15 +2599	135	(5 Eagle)
7.18.19.15.14	134	(4 Jaguar)

Note: Divinatory calendar and therefore long count dates use a 584,284.4 correlation, which results in all events of a single “night” (= period of lunar eclipse visibility) being assigned the same divinatory calendar date.



times) be characterized by an eclipse date one or two days earlier at each near-recurrence in the family.

Careful inspection of figure 13.14 suggests that there are many strings that are continuations, after longer gaps, of an earlier string. This is in fact the case. The complete string structure of this part of the middle region of eclipse occurrence emerges clearly in figure 13.15, in which lunar eclipses are displayed (in black) along with the other full moons at 88-month intervals from them and from one another (in gray):

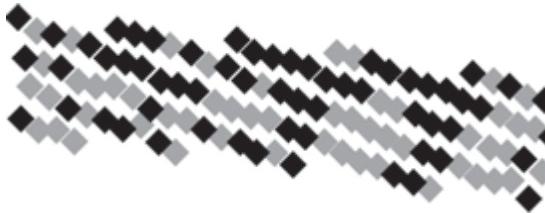


FIGURE 13.15. Eclipse strings in the divinatory calendar (detail). Dark diamonds represent the divinatory calendar dates of lunar eclipses (of magnitude 0.25 or more) that were observed in Mesoamerica. Light diamonds represent other divinatory calendar dates on full moons at intervals of 88 months from one another; every one is the date of a total or partial eclipse visible somewhere on earth.

Mesoamerican daykeepers would not, of course, have visualized these eclipse “strings” in the graphic terms laid out above. To decouple the discussion from the non-Mesoamerican visual representation in these figures, the sets of eclipses characterized visually above, as strings, I refer to henceforth as *eclipse families*. The dates in each family, all of them full moon dates 88 lunations apart, I refer to as *eclipse stations* within that family.

Eclipse families have an important chronological property: successive families lie 405 lunations (about 11,960 days) apart. More specifically, all but the latest eclipse stations in each family fall 405 lunations after an eclipse station in the preceding family, and all but the earliest eclipse stations in each family fall 405 lunations before an eclipse station in the following family. The distance between the families—the average difference between stations—is 11,960 days.

This property accounts for the high frequency with which 2,600-day intervals are immediately preceded or followed by 9,360-day intervals (see “Shorter Recurrence Intervals within 11,960-Day Cycles” above). Two eclipses separated by exactly 2,600 days are immediately successive eclipses within the same family. Because eclipse families lie 11,960 days apart, each of two eclipses separated by 2,600 days must occur $11,960 \pm 1$ days from an eclipse station in both the preceding family and the following family; these yield one interval of $9,360 \pm 1$ days after the preceding and before the following eclipse family.¹¹ When the distance is 11,960 days, an interval of 2,600 days immediately precedes or follows an interval of 9,360 days.

The full-scale family structure of figure 13.15 is a basis for a complete calendrical model for eclipse occurrence anchored in near-recurrences at just two key intervals in the divinatory calendar: intervals of about 2,600 days separate successive stations in an eclipse family, and intervals of about 11,960 days

separate successive eclipse families. This model, in turn, points to a straightforward method for reliably anticipating the dates of eclipses. It can be implemented using two sequential procedures. The first procedure operates within a single eclipse family; the second projects eclipse stations across eclipse families, from one family to the next.

1. For any visible eclipse, of any family, the night of a full moon that takes place 88 lunations (about 2,600 days) later is an eclipse station, predicted to be an eclipse-possible date, if its divinatory calendar date falls within an eclipse-possible zone in figure 13.14; this will in fact be the next possible date on which an eclipse can occur in the same family. Starting with any visible eclipse, then, all subsequent eclipse stations in its family can be projected at 88-lunation intervals, within the temporal limits of the eclipse zone. Applied to the first visible eclipse in each family, the result is a set of eclipse families much like those of figure 13.15, filling almost the entirety of the eclipse-possible zones. The eclipse stations projected in this way include the dates of 571 (89.8 percent) of the 636 Mesoamerican eclipses in the sample.
2. Each of the remaining 65 eclipses is the first in its family, which the previous procedure in principle cannot project. Projecting eclipse stations *backward* from any later station in a family, every eclipse family would be complete, with an eclipse station every 88 lunations. But this is retrodiction, not prediction. To *anticipate* an eclipse family's first eclipse observable in Mesoamerica, and any eclipse stations preceding it in that family, a second procedure is necessary. Taking advantage of the 405-lunation interval separating eclipses of successive families, a straightforward procedure that would probably have been obvious to a Mesoamerican daykeeper astronomer suffices: project the earliest station of each eclipse family from one in the preceding family.

After every eclipse station within one family, there is a full moon in the next family between 11,959 and 11,961 days later. When this full moon falls no later than the latest possible divinatory calendar date of its zone according to figure 13.14, it is projectable as an eclipse station. The chronologically earliest of the stations thereby projected from a station in the earlier eclipse family is the first eclipse station in the next family; so the beginning of each family can indeed be anticipated once the limits of the eclipse zones and their recession are understood. All subsequent stations in this later family can be projected from this first station using the first procedure; most can also be projected from the stations of the previous family.

The result of applying these two procedures is represented in figure 13.16. Every lunar eclipse visible in Mesoamerica is at a projected eclipse station.

a Mesoamerican model for predicting lunar eclipses

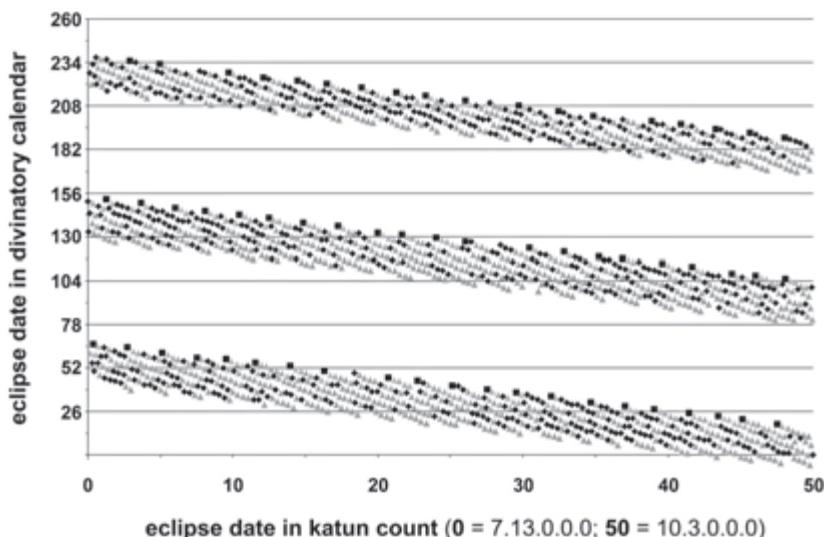


FIGURE 13.16. Divinatory calendar dates of Mesoamerican lunar eclipses of magnitude 0.25 and greater (dark diamonds). Light triangles mark dates of other lunar eclipses projected under the proposed Mesoamerican rules for anticipating eclipses; these are dates of eclipses that were not visible in Mesoamerica or that were of lower than 0.25 magnitude. Dark squares are beginning dates of eclipse families, projected to a following eclipse family at a divinatory calendar date no later than the maximum under the model of figure 13.14.

With an expansion of the eclipse-possible zones to 26 days for each, it would project every lunar eclipse, worldwide, including partial eclipses of magnitude less than 25 percent.

Although figure 13.14, displaying the lunar eclipse history of Mesoamerica, is framed in terms of a katun-based model for eclipse recession, an eclipse-family theory of eclipse occurrence in the divinatory calendar has no intrinsic link to long count chronology; it is anchored solely in the divinatory calendar and would have been available to daykeepers throughout Mesoamerica.

Successive eclipse stations of different families in the same zone of the divinatory calendar are almost always separated by intervals of 17, 18, or 35 lunations (otherwise, rarely, by 53). Most often, the 17- and 35-lunation intervals alternate with 18-lunation intervals—that is, in cycles of 18, 17, 18, and 35 (the starting point is arbitrary). These four intervals add up to 88 lunations, so normally exactly four families are in progress at any moment. About 20 percent of

the time, one family begins shortly before another dies out, and five families are in progress concurrently. Because eclipses in the same part of the divinatory calendar occur roughly at intervals of 520 days apart, and eclipses at multiples of 5×520 (= 2,600) days are part of the same eclipse family, there can be at most five eclipse families in any eclipse zone at any one time. The maximum attested number of eclipse stations in a family is 28, as expected from calculation.¹²

The logic of this structural patterning of eclipses in terms of the divinatory calendar, while stunningly successful, in retrospect seems to have been rather obvious for eclipse observers working regularly with that calendar. It compares somewhat with the 223-month Babylonian Saros cycle, of which an 88-month interval is a recurring subcycle.

CONCLUSIONS

The recurrence of eclipses on the same day of the divinatory calendar may (or may not) have called the daykeepers' attention to the timing of eclipse occurrence in terms of the divinatory calendar and may have been ideologically significant as part of a formal model for the timing of eclipses. However, three specific elements were sufficient to achieve predictive adequacy and perspicacity within the framework of the divinatory calendar:

1. the projection of eclipse stations over a period of 150 to 200 years, from one full moon to another, at intervals of 88 months. The recurrence of an eclipse at 2,599 or 2,600 days, covertly alluded to in a Colonial Zapotec calendar, can now be seen as relating to the special role of this specific interval in Mesoamerican daykeepers' eclipse prediction procedures.
2. a knowledge of something like the earliest and latest possible dates of eclipses at any given time in the three zones of eclipse occurrence in the divinatory calendar. Eclipse zones could have been a construct within Mesoamerican eclipse theory, an analogue to the concept of a node. However, other constructs would yield comparable results—for example, empirical knowledge that the maximum number of stations in an eclipse family is 28.
3. projection of future eclipse families from an immediately preceding family, using the 11,960-day (or 405-lunation) construct.

This procedure does not underpredict; every lunar eclipse visible in Mesoamerica would be anticipated, including those with magnitudes less than 25 percent. It overpredicts only in the obvious way: it predicts eclipses that did in fact take place but that were not visible in Mesoamerica. From the

Mesoamerican point of view, the projected dates would warn of possible eclipses, which might or might not occur.

FURTHER GOALS

There are three direct extensions for further research.

First, it is crucial to extend the work to the anticipation of solar eclipses. Preliminary work with the Espenak-Meeus canon indicates that about 420 solar eclipses were visible from 100 B.C. to A.D. 900, more than 300 at magnitudes 0.95 or greater. As expected by all who have discussed the issue, the structure of the model for anticipating lunar eclipses seems to apply without any structural change, except that the number of days in the regions of eclipse visibility rises from 26 to 28. Individual daykeepers monitoring eclipses of both types together would have had on average one eclipse per year to provide a basis for model building.

As a second and related goal, the structure of the Dresden Codex has to be analyzed in terms of the NASA data on eclipse occurrence and of the models proposed here. There are serious discrepancies between the chronological placement of actual eclipses over an 11,960-day period and that of the eclipse table's stations: the range of its stations is 36 to 38 days wide rather than the 28 days of actual solar eclipses, and it is impossible to fit the stations of the table into the eclipse family framework that characterizes the NASA data.

Both discrepancies have a single source: seven of the nine intervals of five lunations between eclipses (which are not observable) are in the wrong positions for an eclipse family, appearing at an interval of 87 or 89 lunations from another station. By using the standard 88-lunation interval, the 5-lunation intervals stations should reach eclipse stations 5, 12, 20, 27, 35, 42, 50, 57, and 65 rather than 3, 13, 19, 26, 36, 42, 49, 58, and 65. This yields fifteen standard eclipse families, five in each eclipse zone.

For now, the discrepancies suggest that the makers of the table did not construct it, at least exclusively or consistently, by applying a knowledge that eclipse stations occur at 88-lunation intervals. As Juan Ignacio Cases (personal communication, 2013) suggests, further exploration of the structure of the Dresden eclipse table in terms of these models may provide further constraints on the correlation problem.

Third and further afield, for understanding daykeepers' thinking and practices concerning eclipses, it will be useful to work out the extent to which they could have constructed and used these models based exclusively on their own eclipse observations, or those of their recent predecessors going back

perhaps two generations. Generalizing, it is of interest to track the relationship between the lengths of the period in which eclipse records were kept and how fully (what percentage of) the eclipses within a daykeeper's career could be predicted.

Work on these issues is currently underway. There are two significant substantive issues, seeming anomalies in the data on eclipse occurrences in the divinatory calendar, that this paper does not address.

The width of the three lunar eclipse zones in Mesoamerica ranges from 21 to 26 days wide, but in the worldwide data the zones are of uniform width. Persisting over 1,000 years, this difference seems likely to be real.

As shown in figure 13.14, at any moment in time, there is a relatively high density of eclipses and relatively well-represented eclipse families. However, Cases (personal communication, 2013) points out that the longest families appear to be concentrated at any time in just one of the three eclipse regions of the calendar. During the first 13 katuns, the longest strings are concentrated in the middle group of divinatory calendar dates, with more moderate-length strings in the earlier and most shorter strings in the later eclipse regions. They thin out in the earlier two regions thereafter as they become quite long and dense in the latest region, through about the 36th katun; meantime, starting around the 28th katun, the strings become longer and denser in the earlier two groups—especially so in the earliest group.

For both these effects, my speculation is that they arise either from issues relating to latitude or from longer-term cycles in orbital geometry such as precession. In any case, if real, they should be derivable from the mathematical models underlying Espenak and Meeus's published results.

Acknowledgments. Thanks are due above all to Fred Espenak and Jean Meeus for their long commitment to disseminating accurate projections of ancient eclipses. The existence of this study and its most significant results are owed to the urging of the editors, of Tony Aveni, and of Victoria and Harvey Bricker. My instinct was to defer publication of my 2012 SAA presentation to an imagined future in which I would have worked out detailed patterns of relationships among different recurrence intervals in relation to the nodes of the eclipse cycle. It was during the pressure to finish final revisions that its most significant, concluding results and directions were achieved. I am deeply grateful to these friends and colleagues for their appreciation of its germinal form and for their kind insistence on its completion and, in particular, to the editors, Anne Dowd and Susan Milbrath, for accommodating a chapter of its length.

Juan Ignacio Cases Martín and Susan Milbrath provided useful comments on earlier drafts. Adam Gordon produced figures 13.2, 13.3, and 13.12 using the R programming language; Justin Lowry produced the Adobe Illustrator drawing of figure 13.1 from my field drawing of the La Mojarra stela text. Justin Lowry and Tamar de la Concepción Sánchez provided help and advice on figure 13.7.

NOTES

1. The most ancient reconstructible indigenous terms for calendar specialists (e.g., proto-Mayan **aj=q'i?η*, proto-Mije-Sokean **ko.srw*, and proto-Zapotec **ko+lla+ni*) literally mean ‘festival person’; the Mayan-based *daykeeper* is therefore used in this paper as the most straightforward among culturally appropriate English terms for Mesoamerican calendar specialists.
2. Early contact-era documentation, colonial sources, and ethnographic studies indicate that calendar specialists had divination and the scheduling of activities that Westerners treat as religious in character among their occupational skills and tasks. For this reason, time as conceptualized within this calendar can be treated as sacred time, and so particularly appropriate to the celestial sphere. Textually, however, dates in Mesoamerican civil calendars (whether of 365, 360, or 400 days) were also referred to preferentially in terms of their place in the divinatory calendar.
3. The total and partial eclipses of the Espenak and Meeus (2006) canon that constitute the data are those that I judge to have been in the partial phase while the moon was visible in some part of (southern) Mesoamerica. Their identifying numbers in the canon are as follows: 4572, 4576, 4581, 4583, 4584, 4585, 4588, 4591, 4592, 4599, 4600, 4603, 4608, 4610, 4612, 4620, 4621, 4628, 4632, 4636, 4639, 4640, 4645, 4649, 4655, 4656, 4659, 4663, 4664, 4665, 4667, 4668, 4673, 4674, 4677, 4678, 4682, 4683, 4685, 4686, 4690, 4691, 4694, 4695, 4701, 4703, 4704, 4709, 4710, 4713, 4718, 4720, 4721, 4722, 4729, 4736, 4737, 4738, 4740, 4745, 4747, 4749, 4750, 4756, 4764, 4768, 4773, 4777, 4785, 4791, 4792, 4796, 4800, 4803, 4804, 4809, 4810, 4813, 4814, 4819, 4820, 4822, 4824, 4827, 4828, 4831, 4832, 4838, 4840, 4841, 4846, 4847, 4848, 4850, 4854, 4857, 4858, 4865, 4866, 4868, 4873, 4874, 4875, 4877, 4882, 4884, 4886, 4892, 4893, 4898, 4901, 4904, 4905, 4910, 4914, 4923, 4929, 4930, 4934, 4939, 4943, 4946, 4947, 4951, 4956, 4957, 4961, 4966, 4970, 4975, 4977, 4979, 4985, 4986, 4988, 4989, 4991, 4995, 4996, 5002, 5003, 5005, 5006, 5011, 5012, 5013, 5015, 5019, 5023, 5029, 5030, 5034, 5038, 5039, 5041, 5042, 5046, 5050, 5057, 5065, 5066, 5068, 5069, 5073, 5077, 5082, 5090, 5091, 5095, 5100, 5103, 5104, 5111, 5113, 5119, 5120, 5121, 5122, 5128, 5130, 5134, 5135, 5136, 5137, 5138, 5143, 5144, 5145, 5147, 5148, 5152, 5155, 5160, 5161, 5165, 5169, 5170, 5172, 5173, 5174, 5176, 5180, 5187, 5191, 5196, 5197, 5200, 5202, 5204, 5208, 5214, 5215, 5221, 5233, 5234, 5241, 5242, 5244, 5245, 5249, 5250, 5251, 5258, 5260, 5265, 5266, 5267, 5269, 5272, 5273, 5274, 5276, 5277, 5282, 5289, 5294, 5298, 5299, 5302, 5303, 5310, 5314, 5315, 5319, 5324, 5325, 5327, 5328, 5331, 5336, 5341,

5342, 5343, 5345, 5350, 5359, 5360, 5366, 5367, 5369, 5370, 5375, 5376, 5377, 5381, 5385, 5391, 5392, 5394, 5398, 5399, 5401, 5406, 5407, 5410, 5419, 5422, 5427, 5434, 5437, 5439, 5443, 5447, 5450, 5451, 5458, 5462, 5465, 5466, 5468, 5476, 5477, 5478, 5482, 5489, 5491, 5492, 5497, 5498, 5499, 5500, 5501, 5507, 5513, 5514, 5516, 5517, 5522, 5524, 5528, 5532, 5538, 5542, 5543, 5551, 5553, 5555, 5558, 5562, 5565, 5566, 5571, 5572, 5579, 5583, 5587, 5588, 5590, 5597, 5598, 5604, 5611, 5614, 5622, 5623, 5629, 5630, 5635, 5636, 5639, 5640, 5646, 5658, 5660, 5662, 5664, 5665, 5673, 5674, 5679, 5682, 5685, 5688, 5689, 5690, 5695, 5696, 5699, 5701, 5702, 5706, 5710, 5711, 5713, 5714, 5719, 5721, 5726, 5727, 5730, 5731, 5735, 5736, 5738, 5745, 5751, 5752, 5753, 5760, 5763, 5764, 5769, 5772, 5781, 5788, 5796, 5797, 5802, 5805, 5812, 5813, 5818, 5821, 5822, 5825, 5826, 5829, 5833, 5834, 5836, 5837, 5844, 5845, 5861, 5862, 5863, 5864, 5865, 5872, 5875, 5877, 5878, 5879, 5882, 5887, 5891, 5892, 5900, 5905, 5906, 5909, 5915, 5919, 5920, 5927, 5932, 5933, 5935, 5936, 5937, 5942, 5943, 5944, 5946, 5952, 5956, 5961, 5962, 5963, 5964, 5968, 5970, 5972, 5973, 5980, 5981, 5989, 5992, 5994, 5997, 5999, 6000, 6001, 6008, 6009, 6012, 6016, 6020, 6024, 6028, 6029, 6035, 6039, 6043, 6046, 6047, 6052, 6056, 6057, 6062, 6065, 6069, 6070, 6072, 6073, 6074, 6079, 6080, 6081, 6083, 6088, 6090, 6097, 6098, 6100, 6106, 6108, 6115, 6124, 6127, 6129, 6137, 6143, 6147, 6152, 6153, 6155, 6156, 6157, 6162, 6163, 6164, 6165, 6171, 6175, 6180, 6181, 6183, 6184, 6188, 6192, 6193, 6199, 6202, 6207, 6210, 6211, 6216, 6217, 6218, 6220, 6226, 6227, 6228, 6231, 6234, 6235, 6237, 6238, 6244, 6246, 6254, 6263, 6266, 6267, 6268, 6277, 6278, 6283, 6284, 6287, 6292, 6295, 6296, 6297, 6302, 6303, 6306, 6311, 6315, 6320, 6321, 6323, 6324, 6333, 6334, 6339, 6343, 6348, 6350, 6351, 6352, 6357, 6359, 6360, 6366, 6367, 6368, 6376, 6378, 6379, 6386, 6388, 6399, 6404, 6405, 6406, 6407, 6415, 6416, 6421, 6422, 6425, 6429, 6432, 6433, 6434, 6439, 6440, 6441, 6443, 6448, 6452, 6456, 6460, 6461, 6467, 6470, 6475, 6479, 6484, 6485, 6486, 6487, 6488, 6494, 6496, 6503, 6504, 6505, 6512, 6514, 6515, 6516, 6517, 6522, 6534, 6540, 6542, 6543, 6550, 6551, 6556, 6557, 6560, 6565, 6567, 6568, 6569, 6574, 6577, 6578, 6583, 6584, 6587, 6590, 6593, 6594, 6600, 6601, 6609, 6613, 6617, 6618, 6619, 6620, 6621, 6629, 6632, 6637, 6638, 6648, 6649, 6655, 6661, 6666, 6671, 6675, 6676, 6684, 6688, 6689, 6691, 6692, 6693, 6698, 6699, 6700, 6701, 6702, 6706, 6709, 6710, 6714, 6715, 6717, 6718, 6725, 6726, 6731, 6732, 6740, 6744, 6745, 6749, 6750, 6751, 6757, 6758, 6766, 6776, 6777, 6783, 6787, 6794, 6797, 6801, 6802, 6807, 6810, 6812, 6816, 6817, 6818, 6822, 6823, 6824, 6825, 6826, 6831, 6838, 6840, 6841, 6842, 6849, 6852, 6853, 6856, 6862, 6867, 6872, 6873, 6874, 6876, 6888, 6891, 6892, 6904, 6908, 6912, 6913, 6916, 6919, 6923, 6924, 6929, 6934, 6939, 6941, 6942, 6943, 6944, 6945, 6953, 6958, 6960, 6963, 6964, 6969, 6972, 6973, 6975, 6976, 6980, 6981, 6983, 6984, 6988, 6989.

4. These specific dates were chosen because of their relation to *long count* chronology, a system used by lowland Mayans and epi-Olmecs as a linear calendrical framework for historical and astronomical records and for scheduling certain kinds of royal/political rituals, including the erection of royal monuments. Its key chronological unit was the katun, a period of 20 years of 360 days each; the long count was in effect a divinatory calendar writ large, with long count dates repeating after 260 katuns (rather than 260 days).

The span between 100 B.C. and A.D. 900 corresponds roughly to the interval between the long count dates 7.13.0.0.0 and 10.3.0.0.0, according to the generally accepted Goodman-Martínez-Thompson family of correlations between European calendars and long count chronologies. This span yields three katuns of observations before the katun (7.16.0.0.1 to 7.17.0.0.0) during which the first three extant monuments bearing dates in this chronological framework were probably erected: Chiapa de Corzo "Stela" 2 (7.16.3.2.13; 36 B.C.), Tres Zapotes Stela C (7.16.6.16.18; 32 B.C.), and Takalik Abaj Stela 2 (probably 7.16.x.x.x; otherwise 7.11.x.x.x or 7.6.x.x.x).

5. For example, in the Gregorian calendar, with a change of date at midnight, the lunar eclipse that was visible in Zapotec country in the early morning of January 11, 1694, fell 2,600 days after that of the evening of November 29, 1686, on the same date in the divinatory calendar. If the day changed at noon in the divinatory calendar, however, these eclipses would be separated by only 2,599 days. See the section "Background" below.

6. The frequency distribution of the number of eclipses after (equivalently, before) a given eclipse at an exact a multiple of 520 days is as follows:

number of following eclipses:

1	2	3	4	5	6	7	8	9
<i>frequency:</i>								
155	117	82	48	31	10	4	2	1

When there are n eclipses on the same divinatory calendar date, there are $n(n+1)/2$ pairs of such eclipses and therefore of intervals between eclipses that took place on that date. In the overall sample, the frequency distribution above therefore yields 1,095 intereclipse intervals that are exact multiples of 520 days.

7. The main reason for the high frequency of this interval is its precision: It departs from a perfect commensuration of the divinatory calendar with the eclipse cycle by just 0.11 day, the smallest deviation of any recurrence interval within the observational experience of an individual daykeeper. In fact, it takes 248×520 days, more than 350 years, for a commensuration with an even marginally smaller deviation, and by then the internodal cycle and the 520-day cycle have separated by more than 18 days.

8. This unique intereclipse interval of 6,760 days occurs after an eclipse that was preceded by another exactly 2,600 days earlier; so it is part of the very common intereclipse interval of 9,360 days.

9. There could be such an instance if the divinatory calendar date were to change around midnight rather than dusk.

10. If this is the case, then the point at which an adjustment of one day should be made, in the first pass through the table, is after about 7,141 days. The relevant point happens to be at the 41st or 42nd eclipse stations, which are recorded at the

beginning of p. 53b; this happens to be directly under the start of the table at the beginning of p. 53a.

11. The earliest couple of stations in a family will typically not be followed by one in the next family 405 lunations later, and the latest will not be preceded by one; at the extremes, then, there can be at most one 2,600- and 9,360-day pair of intereclipse intervals in succession rather than two.

12. From one projected eclipse in a family to the next, eclipses recede by about $2598.691/7140.895 = 0.364$ day in the divinatory calendar. The maximum and minimum dates in the divinatory calendar are therefore reduced by this amount; meantime, the date in the divinatory calendar of successive stations is reduced by an average of 2,600 days less 88 lunations—on average by 1.308 days. As a result, over the course of 88 months, the position of the next eclipse in a family falls, on average, 0.944 day earlier in the eclipse-possible zone of the divinatory calendar. The length in stations of an eclipse zone spanning 26 days is therefore $26/0.944 = 27.5$ stations; 28 stations can fit in this span if the date of the first is early enough.

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ANTHONY F. AVENI

The title of this chapter reflects the two-part nature of my invited conference overview. First, I will focus on the chapters that deal with the theme of cyclicity and how the study of textual materials reveals the way the Maya understood that temporal concept. Second, I will talk about the chapters that set directions for alignment studies in the archaeological record.

Chapter 12 by the Brickers is among four in the collection that deal with eclipses and eclipse warning tables. It demonstrates that the “commensuration principle” in Maya calendrics is alive and well. The guiding template in the building process that characterizes Maya timekeeping is based on the desire to discover periodicities that resonate with each other in the ratio of small whole numbers. A dramatic example of this principle was revealed most recently in the discovery of the long codex-style number sequences painted on the north and east walls of Structure 10K-2 at Xultun, Guatemala, from the early ninth century (Saturno et al. 2012). These extraordinary numbers commensurate not only with a host of astronomical and calendrical periodicities but also with one another (Aveni et al. 2013).

The Brickers’ study constitutes a tidy lesson on how the Maya managed to impose ritually motivated constraints on canonic astronomical periodicities, not unlike what Western computists did in fixing the Paschal date (Aveni 1987). They offer four examples of the commensurate quality of the Teeple Number, 520^d (2×260^d), involving multiples of 3, 7, 9, and 23 (Teeple

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1931). They also make a strong case that the length of the Dresden lunar table was deliberately chosen to be $11,960^d$ (23×520^d) because that number resonates with the Teeple Number. The table of commensurations (Aveni 2001, table 5), which they used as a resource in their study, was originally designed to test the validity of the so-called 56-year eclipse cycle that Hawkins (1963) posited for Stonehenge. That table consisted of integral and half-integral multiples of the synodic and draconic lunar months, periods that Western astronomers might have employed to discover long-term eclipse cycles. Reviewing their chapter, I noticed that some of the cycles in my table are present in the Dresden lunar table; for example, $2,244^d$ is the interval between the beginning of the table and Picture 1, while $1,033^d$ is that separating Pictures 1 and 2. The Babylonian *saros* of $6,585^d$ appears as a cumulative as well. Even though one can derive most cycles in the Maya calendar by successively multiplying 260^d (and sometimes 365), the Bricker supply evidence that this is not what calendar keepers actually did. Rather, the Maya were looking for numbers that *maximized* commensurability. This is why the Xultun numbers were favored and this is also why those who composed the Dresden lunar table chose $520^d = 2 \times 260^d$ over 260^d . The moral seems to be: when it comes to Maya calendrics, Occam's razor just does not cut it.

John Justeson's chapter 13 on indigenous cyclical modeling is based on historical patterns of eclipses. We know from his earlier work (Justeson and Kaufman 1993) that La Mojarrá Stela 1 records an eclipse event near the time of the greatest elongation of Venus. Justeson deals with the obvious next question: how might the Maya have developed commensurate schemes to fit this record? His computer modeling discloses recurrences of eclipse phenomena in subsequences of 3, 5, and 8 Venus periods and 10, 17, and 27 lunar eclipse cycles. Once again, the $11,960^d$ interval ($= 23 \times 520^d = 405$ lunations = 69 nodal passages) emerges as the seminal long cycle for restructuring an overall eclipse theory in accord with the Maya philosophy of time. One of Justeson's most convincing models is based on Colonial Zapotec almanacs, wherein eclipses are tied to saints' feast days. Justeson searches for low average deviations in the lengths of cycles wherein eclipse dates coincide with the feast days of saints. Justeson tests his models for statistical coincidence, a procedure often neglected in theoretical calendrical modeling. In my view, his chapter is a guide for how to design long-term Maya calendar models in a way most likely to have corresponded to the way Maya astronomers operated. His is a refreshing antidote to the less tenable habit of searching through the codices for large intervals that happen to approximate cycles familiar to Western astronomers, then offering no concrete support from other quarters in the Maya record.

In chapter 7, Gabrielle Vail's study of eclipse cycles and world destruction is reminiscent of a recent work by historian Elaine Pagels (2012), who relates cosmic war and divine victory depicted in the biblical Book of Revelation to actual events that took place in the first century A.D. Roman Empire in the Middle East, which were interpreted after that book was written as a prophecy about the end of the world. As in Justeson's chapter, a special relationship between Venus and the Sun provides the guiding metaphor in Vail's work. Venus is the active agent in the drama, the Sun's antagonist: it overcomes the Sun. This celestial metaphor can be applied to describe the way the two luminaries move together across the sky as they reenact the eternal battle between the sky and the underworld deities depicted in the Santa Rita murals and elsewhere. One who has witnessed the sudden daytime darkness that attends a total eclipse of the sun can fully appreciate how such a phenomenon suddenly and profoundly alters the natural environment: as the Sun is blinded, sharp shadows occur, and one sees the yellow-brown-tinged faces of those who watch the event. I describe one such phenomenon and its possible relationship to the East Yucatan Postclassic period (A.D. 900–1519) iconography of the Diving God, who is also pictured with a Venus-glyph face on page 58b of the Dresden lunar table (Aveni 1992, 76–78).

Finally, among those presentations specifically related to eclipse cycles, we have, in chapter 6, Susan Milbrath's work on a seasonal calendar in the Codex Borgia from Central Mexico, a subject dealt with at great length in her recent book (Milbrath 2013). One of the major advances in the study of Maya writing is that many of the almanacs in the Maya codices are now thought to portray periodically revised real-time events, as opposed to endless cycles of time (Bricker and Bricker 2011). Here Milbrath extends her continued sleuthing of pages 29–46 in the Codex Borgia as a seasonal festival calendar that chronicles the movement of Venus between two worlds, by framing real-time events in realms of the natural world other than celestial, including meteorological, zoological, and botanical phenomena. She argues that the major real-time link that actually dates the seasonal narrative resides in the total eclipse of the sun visible across Central Mexico on August 8, 1496, and reported on page 40v of the Codex Telleriano-Remensis and elsewhere (Aveni and Calnek 1999).

Against the tide of the popular view of the 2012 phenomenon, seen as the Maya prophecy of the end of the world by flood, I have argued (Aveni 2009, 48) that the celebrated “flood scene” depicted on the final page of the Dresden Codex could have been a framework or metaphor for the passing of old ways and the renewal process that takes place at the turn of all cycles great and small. John Carlson's chapter 8 offers a reasoned, detailed argument that the

scene is more likely to represent agricultural fertility. One of the strongest elements of his argument is that he marshals evidence not only from the ethno-historic record, but also from related iconography on other pages of the codex as well as other codices.

Dealing less with cosmic cycles, the chapters by Clemency Coggins (chapter 5) and Flora Clancy (chapter 9) focus more on sky objects, the North Star (North Celestial Pole) and the moon, respectively. Coggins compiles an abundant, useful compendium of possible references to polar constellations, especially those embedded in the God C-North-Monkey iconographic complex. She borrows from Chinese cosmology the idea that the North Celestial Pole was the personification of divinity and the immortality of the nascent state. While a visible polar pivot may provide a cosmic metaphor in North Temperate Zone latitudes (e.g., the latitude of Beijing is 38° north), where the circumpolar constellations are very prominent, it is more difficult to mount the same argument in the low-latitude Tropics, where the celestial pole is situated low in the sky. Some may also disagree with Coggins on whether the Maya calculated the precession of the equinoxes and whether they perceived the Milky Way as a cosmic tree, at least in antiquity.

Flora Clancy's work on the ancient Maya Moon sparks questions about how people around the world might have experienced the blotchy silvery disk that opposes the sun. The appearance of the figure of a rabbit, for example, has often been used by diffusionists to suggest that cultures around the world who recognize it must have copied from a single parent source. I believe autochthony wins the day on this issue: the gestation period of the rabbit is the same as the length of the month measured by the lunar phases. Moreover, the menstrual cycle in *Homo sapiens* also claims a universal lunar connection.

Clancy's paper also led me to think about why the Aztec lunar deity Coyolxauhqui has "gone to pieces"; that is, why that lunar deity is represented on the famous Aztec stone of the same name as a segmented figure. One look at the chopped-up nature of the dark maria that comprises the lunar surface might invite the imagination behind the eye to express her dismembered effigy that way. As I have shown, to the perspicacious skywatcher the myth of Huitzilopochtli's slaying of his sister as well as her 400 brothers is kinetically acted out in the monthly and seasonal movements of the sun, moon, and Pleiades in the night sky over the Templo Mayor (Aveni 2006).

The second half of this overview addresses building alignments and archaeology. Some time ago I suggested that one explanation of certain differences between astronomical reference systems developed by indigenous civilizations in the Tropics, as opposed to those that flourished in temperate latitudes,

might reside in the contrasting arrangement of the sky as seen from those parts of the globe (Aveni 1981). In that publication I suggested that Temperate Zone systems (e.g., Chinese and Greek) were likely more attracted visually to a coordinate system based on a fixed pivot relatively high in the sky (the celestial pole) and the circle 90° from it (the celestial equator), while, on the other hand, the zenith-nadir axis and the circle of the horizon might more appropriately contribute to the organizational basis of many tropical systems in Mesoamerica and the Andes.

Do two different concepts of celestial space exist? Though that was never the question, Western historian of astronomy Owen Gingerich (1982, 333–36) replied: “The answer is no . . . I was never convinced that there is a well-defined fifth direction of up down developed in their cosmic views . . .” Later he added: “I am nevertheless prepared to believe that there really are different ways of thinking about what the sky does, and that an important difference is the latitude of the observer.” Reflecting on Gingerich’s statement three decades later testifies to the progress achieved in the study of horizon-based astronomies.

I think it appropriate to begin the final section of the overview with a discussion of chapter 2 by Ivan Šprajc, for he has established a long record of detailed alignment studies. In chapter 2, Šprajc synthesizes and connects my earlier work, which he generously reviews, with his own studies of Central Mexican architectural orientations to the sun at horizon, separated by 13-day (less tenable in my view) and more convincing 20-day intervals and keyed to the scheduling of agricultural activities and their corresponding rituals. Šprajc’s patient and prolonged data collection at eighty-seven Maya sites now enables statistical analyses to be conducted and a systematic approach to be followed whereby one can correct and improve earlier hypotheses and generate new ones. Šprajc also extends my work on buildings that are oddly shaped and/or skewed out of line relative to prevailing site axes. As Šprajc (1993) once did regarding the orientation of the House of the Governor at Uxmal, he offers an alternative hypothesis for that of the Templo Mayor. His potential lunar alignments at the Postclassic East Yucatec site of Paalmul, though difficult to establish, are intriguing.

I congratulate former student Ronald Faulseit on the completion of his ethnographic/archaeological dissertation in the Dainzú (Oaxaca) Archaeological Zone, the results of which he reports in chapter 4 of this volume. Dainzú is one among several examples of Mesoamerican sites flanked by a prominent mountain on the north. Other examples include Teotihuacán, Tenayuca, Tenochtitlan, and Copán. I have pointed out (Aveni 2001, 226–35), along with others (e.g., Heyden 1975) that the planners of Teotihuacán surely confronted

a sky-mountain-cave scenario when they heeded the cosmic mandate to follow nature in establishing the layout of their city.

While most archaeologists now accept the view that the sky played an important role in city planning, some have been critical on the grounds that a significant number of arguments that posit this idea are weak (see Aveni 2008, 751–92 for a discussion of both sides of this important issue). For example, Michael Smith (2003, 2005) inquires what kind of cosmological role, can we reconstruct it, and bearing on what empirical evidence? I believe that Faulseit's paper answers many of Smith's archaeologically based questions and that he makes a strong case for cosmo-terrestrial dualism by demonstrating the relationship between archaeological remains from the "northern-up" domain (Cerro Danush), which relate to the sky, rain, and agriculture, to those on the "southern-down" realm, from the site of Dainzú, that carry jaguar, earth, and warfare symbolism. Although I would not characterize it as an *axis mundi*, a term which has many meanings (Eliade 1954, 12–13; Isbell 1982), the alignment of the December solstice sunrise to the southeast and the June solstice sunset to the northwest does nevertheless seem to serve as the dividing line between these two reciprocal realms.

Anne Dowd's paper (chapter 3) on Maya architecture draws on another Eliadean construct, the *hierophany*, a manifestation of the sacred in the natural or built environment, which first attracted attention in Maya studies via Chichén Itzá's descending serpent (Rivard 1971). Rebirth of this myth now enjoys a considerable pop-culture market influence in sacred travel, especially in the wake of the 2012 phenomenon (Aveni 2009). Here, following her work at Calakmul, which helped inspire our collaborative project on E Group-type alignments (Aveni, Dowd, and Vining 2003), Dowd interprets the architectural hierophany as part of a scheme for setting up a place (I would add time and space) wherein one establishes or reestablishes one's cultural identity with the transcendent. Often, as in the case of the Inti-Raymi winter solstice "hierophany" at Tiahuanaco, no visible phenomenon is actually required.

I conclude this section with comments on two chapters that deal with specific archaeological artifacts. Some thirty-seven years after Alexander Marshack (1977) published his analysis of the Las Bocas mosaic mirror, concluding that it constituted a lunar calendar, Prudence Rice, in chapter 11, offers a more expansive study of her own. Adopting the Marshack formula—one polygon = one day—she finds the 260-day count, the 365-day vague year (with a leap year correction), and the 584-day Venus cycle present in the plan, although some double counting is involved. The way I view it, the major structural principle in the piece is based on the number 4; e.g., there are vertical strips (reading from left to right) that consist of 16×4 , 16×4 , 16×4 , $15 \times 4 + 3$, 9×4 (+ 6 + 5)

polygons, and, finally, a horizontally halved section consisting of 6×4 (?) and 3×4 , with a few misshapen polygons squeezed in. To her credit, Rice is her own best skeptic. She admits that the one-of-a-kind nature of the artifact is a drawback regarding her hypothesis. She also concedes that just because one can make an artifact “work” does not mean that it was so conceived.

If pecked crosses really functioned as counting devices, whether for calendrical purposes or as game boards (Aveni, Hartung, and Buckingham 1978), a perennial question has always been: where are the counters or tokens? To raise that question anew, in chapter 10 David Freidel and Michelle Rich make reference to Barbara Voorhies’ (2012) recent report of the discovery of pecked game boards in Tlacuachero, dated to 5,000 B.P. I was intrigued to learn that Voorhies’s “dice” have an incised quadripartite shape—quite like the quadripartite circles and Maltese crosses with which the (much later) Teotihuacán pecked circles have been compared. Freidel and Rich encourage us to close the gap between interpreting such artifacts as *either* calendric devices *or* game boards, in much the same sense that I have strived to integrate the “precise observatory” and “performative ritual theater” assignations to astronomically oriented buildings.

Regarding alignment studies in general, I believe the overused word *observatory* often opens the gate to the ethnocentric pathway that any measured quantity that does not yield a precise fit can have had nothing to do with astronomy. I prefer to think that ceremonial architecture might have provided not so much a laboratory for the acquisition, documentation, and analysis of precise, quantitative astronomical information (what happens in a modern astronomical observatory), as a sacred place, where the conduct of cosmically based ritual could be rendered most efficacious in the eyes of the practitioner. In the practical architectural sense, this would have amounted to “laying squares,” to use an Old World urban architectural term, in such a manner that whatever celestial object or phenomenon might have been configured into the divinatory process would be delivered to the proper place, be it the top of a temple, the doorway of a building, or the open plaza where a debt payment was scheduled to be transacted with the gods, at the correct time. Such a perspective places ancient Maya astronomy and cosmology as much in the realm of theater as science.

In sum, this rich collection of astronomical and calendrical studies has managed to touch on practically every discipline contiguous to the field of cultural anthropology—a testimony to the way skywatching has been integrated into its true parent discipline, where I suggested (Aveni 1979) that cultural astronomy (then called archaeoastronomy) really belongs.

I know the contributors share with me the belief that one of the seminal rewards associated with the cross-cultural study of cosmic phenomena lies in the capacity to discover cultural universals, while at the same time to uncover diverse ways we might never before have imagined of interpreting the lights that shine in the sky.

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